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BRIEFLY TOLD.

THE ADDRESS OF PRESIDENT BEAL.—There were many interesting happenings at the recent meeting in New York of the American Gas Light Association, and in several ways it differed from earlier sessions of that body. Perhaps the most notable difference was to be seen in the fact that less genuine comradeship in general was shown. The delegates seemed to gather in special squads, rather than as at former meetings where the delegates and guests all appeared to know, or to want to know, each other. Of course, the main reason for this is in the fact that the Association's roll has grown to such a length as to fairly preclude the old-time way of "getting together" on acquaintanceship account. The meeting, however, was a good one, far better than many thought it would be from the preliminaries' announcement, and its history will compare favorably with those "gone before." One main reason for the smoothness of the proceedings is easily traceable, and the tracing leads direct to the cleverness and tact of the President, Mr. Wm. R. Beal, whose many years of excellent service in connection with the gas supply of upper New York city, or in the great district north of the Harlem river, has made his name as an open book to the gas suppliers. Cool, determined, forceful, wideawake, logical, reasonable and just, it is not to be wondered at that he could well and tactfully direct the doings of a technical body; and that is what he performed to the full. As a presiding officer's duties are administrative as well as argumentative, and as his administration was without flaw, it is doubly pleasing to note that his doings in the argumentative line, made necessary by the presentation to his fellows of a presidential address, were fully up to everything he did in his ministerial capacity. The text of the presidential message, which will be found in the JOURNAL for the 27th ult.—we regret very much that the address had to be printed separately from the regular proceedings report, but under the present custom of the Association in respect of printing the proceedings, such disjointed reporting is necessary—is notable for its temperateness and scope. In the opening paragraphs, Mr. Beal gave an excellent summary of the history of gas making and selling in the city of New York, that affords an object lesson which might be referred to by others engaged in like business in other large—yes, and many small—cities of our country, when threatened with unreasoning competition. In connection with that section of the address we hope its real meaning and significance, respecting his directing attention to the salutary effect upon the gas industry as a whole, through wise legislation of the sort that resulted in the establishing of the Massachusetts Board of Gas and Electric Light Commissioners, will be carefully considered. The address is replete with wise and timely suggestions leading up to the above subject, and it might not be amiss did we quote one of these in full, which is to be found in these lines: "As our plants get to be known and are discussed by promoters and investors (changing owners as so many have with readjustment of bond and stock issues), conservative managers are looking to the establishment of State Gas Commissions, and to that judicial treatment which will safeguard our properties against senseless competition and reckless exploitation." While Mr. Beal is not the first of the Presidents of our several Gas Associations to call attention to the desirability, for investor and the public alike, of having the industry under fair judicial supervision, after the manner patterned by the

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Commonwealth of Massachusetts, he nevertheless has advanced better reasons therefor and voiced them in a more convincing and forcible way than was the case with his predecessors in this line of argument. It is more than likely that his careful and timely advice or suggestion will lead to some tangible action in this instance on New York State account. Mr. Beal also gave considerable attention and space to a review of some notable improvements in gas making methods during recent years, his references to the inclined retort system being especially interesting. Referring thereto, as our readers know, during the course of the address he exhibited a sectional view and ground sketch of the new retort house in course of erection at the works under his control (those of the Northern Union Gas Company) at the foot of East 138th street, the story of the development of which plant, under his systematic, careful guidance since his connection therewith, which covers a full three-term decade, would read like a long chapter from a "fairy tale." With his usual impartiality, which way of doing is his from experience, in the new retort house Mr. Beal is installing good working specimens of English and German types of inclined benches, and in time he will certainly tell us why he prefers the one type to the other, because he will then speak from practical experience. Perhaps all will not completely agree with Mr. Beal in his thoughts respecting the measure of success that has attended the operating of the Educational Class maintained virtually under the auspices of the Association. That good has come therefrom may not be doubted, but that such good is fully commensurate with the sum that it has cost is open to question. In fact, that Mr. Beal is not altogether certain on the balance as to results and costs would seem to be shown in his statement, regarding "correspondence schools" in general, that "A perfect system of the kind has not yet been found." We all will have to concede the truth of that. Take it all-in-all Mr. Beal's address was in the very best vein of thought of a man who has preferred fact to fancy, the real to the unreal; and it is our pleasant prerogative to here say that his address to the Thirtieth Meeting of the American Gas Light Association was a solid and useful contribution to its proceedings.

NOTES.—

THE *Journal of Gas Lighting* announces that the ruling powers of the two representative gas engineering bodies of England—the Institution of Gas Engineers and the Gas Institute—have agreed upon and ratified articles for the amalgamation of both under the distinctive title of the Institution of Gas Engineers Thus is happily ended a division that never should have occurred. Our English correspondent proposes to give to us in a short time a special article bearing on the causes that led to the breach and the effects that brought about its closing.

MR. J. A. MAYERS, who some time ago resigned his position as Eastern representative of the Western Gas Construction Company, of Fort Wayne, Ind.. has joined forces with Captain W. H. White, of this city. Mr. Mayers will have engineering charge of the Captain's trading in the gas works construction line. Of course, their joint headquarters will be in No. 62 Wall street, New York.

MR. R. B. GOODMAN, formerly in the service of the White Plains (N. Y.) Gas and Electric Light Company, has been appointed Superintendent of the reorganized Saugerties (N. Y.) Gas Light Company. The Company has secured suitable office quarters in the Maxwell House block.

MR. JOHN DAUB, who was formerly prominent in the affairs of the old Pittsburg (Pa.) Gas Company—he served it as Vice-President for several terms—died at his home in that city the morning of the 11th inst. He was in his 76th year.

MR. ALTEN S. MILLER will not locate permanently in Baltimore until January 1, 1903. Meanwhile he will divide his time between his Baltimore and New York duties.

THE franchise rights of the Sea Shore Gas Company, which was organized recently for the purpose of supplying gas in Manasquan, N. J., have been purchased by Mr. Martin Maloney, who, if we mistake not, is the owner of similar rights in and for Spring Lake, N. J.

A DIVIDEND of 3 per cent. has been declared on the preferred stock of the Columbus (O.) Gas Light and Heating Company. It is payable the 25th inst.

THE Municipal Gas Company, of Albany, N. Y., is rearranging its labor schedule to conform to 8-hour shifts. In fact the scheme goes into effect in its electric lighting division the 1st prox.

ONCE more the deacons of Ocean Grove, N. J., have been appealed to to construct a gas plant "within its borders;" failing which construction the residents would be satisfied with permitting the Consolidated Gas Company, of New Jersey, to minister to their needs.

[LIMITED ABSTRACT.—Continued from Page 673.]

PROCEEDINGS, THIRTIETH ANNUAL MEETING AMERICAN GAS LIGHT ASSOCIATION.

HELD IN THE GREEN ROOM, NEW YORK ATHLETIC CLUB, NEW YORK CITY, OCTOBER 15TH to 17TH, 1902.

FIRST DAY—WEDNESDAY, OCTOBER 15.—MORNING SESSION.

The next thing to engage the attention of the Association was the paper, by Mr. McDougald Dexter, of Columbus, Ga., on

THE CARE AND MAINTENANCE OF INCANDESCENT GAS BURNERS,

which, in the absence of the author, was read by Mr. James Ferrier, of Columbus, Ga.

[For the text of Mr. Dexter's paper, see JOURNAL, Nov. 3, p. 626.]

Discussion.

Mr. Clabaugh said he had no doubt of the advisability of gas companies looking after their incandescent burners. If not adjusted properly they will burn badly thus giving a wrong impression as to their value, and the companies get the blame. He believed that a gas company should sell mantles and all other appliances, and should maintain the incandescent gas arcs free of cost to the consumer. A consumer who would pay a bill of $70 or $80 per month without complaining would sometimes grumble at a little bill of $1 for repairs to an incandescent burner outfit.

Mr. W. C. Morris objected to the use of the term "gas arc," as made in the paper and by the last speaker. There was no such thing as a "gas arc," and he thought they should have enough inventive ability sufficient to coin a new term, if one were needed, and not borrow it from a competitor in business.

Mr. Clabaugh replied that he saw no reason why gas men should not benefit by the advertising which their competitors had done for a number of years, and use the term "arc."

Mr. A. E. Forstall did not think that gas companies appreciated the importance of maintaining incandescent gas burners. The English gas companies who were usually much slower than the companies in this country in taking up matters of the kind, had within the past year, from information gained from several articles in the *Journal of Gas Lighting*, been advocating the maintenance of incandescent gas burners by the companies, either at a fixed price, including all repairs to glassware and mantles, or at a price which only included mantles, or simply at the cost of renewals. Many English companies were undertaking this maintenance, and as doubtless many companies in this country were doing the same thing, they would like to hear how it was being done, so that those who are not doing it may know how to begin.

Mr. Ferrier stated that, in Columbus, Ga., he had become convinced of the absolute necessity of some system of maintenance of incandescent gas burners, and he had gone over the statistics to find out the average cost of maintenance of mantles and chimneys to several consumers, but he had not been altogether guided by that in fixing rates. The real question was how much a consumer would pay, and pay willingly. Whenever objections were made to the payment of a bill for mantles the agent would take out a card on which were the rates for insurance, and would ask the consumer if he would prefer that plan. This had, to a certain extent, solved the question.

On motion, the Association adjourned, to reconvene at 10 A.M. of the following day.

SECOND DAY—THURSDAY, OCT. 16—MORNING SESSION.

The sessions of the second day were commenced at 10 A.M., Thursday, October 16th. The President called for the paper, by Mr. George McLean, of Dubuque, Ia., on

GAS RATES AND A FRANCHISE TAX,

which, in the absence of the writer, was read by the Secretary.

[For the text of Mr. McLean's paper see JOURNAL, Oct. 20, p. 543.]

Discussion.

Mr. Egner suggested that a judicious use of some of the points made by the writer, by printing them in the local newspapers, might affect public sentiment in favor of gas companies.

The Secretary thought it time that those interested in gas companies should realize the fact that the work of regulating rates, with the adoption of systems of taxation which discriminated against gas companies, was going on all the time, and it was important that those interested should endeavor to work out a system which would be fairer to all.

Mr. Littlehales said he believed it would be to the public interest to

have a monopoly in the gas business provided such monopoly were regulated. He believed that a Gas Commission in every State would not only be a benefit to the gas companies, but to the consumers as well. As any over-capitalization of gas companies crippled the business and taxed consumers unjustly, it was an evil to be guarded against.

REPORT OF THE COMMITTEE ON ADVERTISING.

Mr. E. G. Pratt, of the Committee on Advertising, read the following report:

Your Committee begs to report progress, as follows:

A circular letter was sent out in September, 1902, asking for subscriptions to an advertising fund on the basis of $2 per 1,000 of population. To this letter less than half of those to whom it was sent made reply, but more than 80 per cent. replying indorsed the scheme and pledged their support to the plan. The greatest obstacle your committee encountered is their inability to apportion the cost of this advertising in exact proportion to the benefits received. Only one gas company flatly refused to support the movement, either morally or financially, although nearly 20 per cent. of the repliers agreed to subscribe only conditional upon the committee obtaining almost general support from all gas companies. One manager of a gas company, who refused to subscribe unless subscriptions were received from all, was asked why he should withhold his subscription if it could be demonstrated that he was securing a full return for money expended, and he replied that he would not spend one dollar for any form of advertising, even though it brought him desired results, if others were to receive the benefit of his expenditure without contributing proportionally. This spirit, if extended, would limit the usefulness of this committee.

Recognizing this obstacle early in our work, one member conceived the idea of publishing a journal for direct distribution amongst the non-consumers of the subscribing companies. This plan was carried out to a point involving an expenditure of many hundred dollars, but was temporarily abandoned, owing to postal restrictions. This plan permits of localizing the advertising to the exact point desired, and enables all subscribers to determine the exact returns on their expenditures.

We are now in touch with the representatives of one of the largest publishing houses of the country, who are attracted by the original plan of this committee of publishing a special journal for the advertising of gas for all purposes. They now agree to publish a high-class, home journal and put it in the hands of non-consumers at a price much lower than your committee could do, and they feel so certain of meeting with the support of gas companies that they have already started plans for the publication of such a journal on an enormous scale, and will have samples of the first edition in shape for distribution on November 1, 1902. The active principals in the enterprise are three wideawake and energetic men, one of whom is a well-known advertising man, and especially well-known amongst gas companies; the second is the ex-publisher of a magazine of national reputation; and the third is the business manager of one of the best known publishing houses in the world. They have secured financial backing in excess of $100,000, a portion of which has already been supplied to demonstrate the value of the plan, and the rest is immediately available whenever it is demonstrated that the plan will receive the support of gas companies.

The subscriptions will be supplied at a cost of less than 50 cents per year each, and 6 months' subscriptions will be accepted.

The publishers recognize the fact that the gas companies will not continue their subscriptions unless the plan brings results, and in the event of consumers being obtained these particular subscriptions would be apt to be stricken from the gas companies' lists; and, therefore, their salvation lies in their ability to publish a journal of such high standard that, once it has been introduced into a home, a bona fide, paid subscription will eventually result.

As this is a commercial enterprise, your committee does not care to go further than to urge gas companies to support this plan until its worth can be demonstrated. The publishers are now gathering up all advertising matter aimed to promote the use of gas, and each month hereafter a publication will be issued reproducing the best of this advertising for circulation amongst every gas company in the United States. The collection, selection, compilation and distribution of this advertising matter amongst gas companies is alone sufficient reason for undertaking this work, and your committee has other plans in view which will be announced when the proper time arrives.

The report was approved and placed on file.

A BRACE OF INVITATIONS.

The President reported that the Consolidated Gas Company had invited the Association to visit its various works, and offered to furnish a steamboat as a means of transportation from works to works, and also for a ride about the harbor if so desired. He also reported the receipt of an invitation from the Manhattan Railway Company to the Association to visit the power house of the Company, on 74th Street and East River. These invitations were accepted, and the Secretary was instructed to convey to each of the Companies the thanks of the Association.

The President then announced the paper by Mr. George S. Clarke, of Kansas City, Mo., on

THE CLEANING AND REPAIRING OF GAS STOVES.

In the absence of the author the paper was read by Mr. Rollin Norris.

[For the text of Mr. Olarke's paper see JOURNAL, Nov. 3, p. 627.]

Discussion.

Mr. R. Norris said that about 6 years ago during a gas war in Kansas City, Mo., the contending companies adopted the plan of furnishing free gas ranges to all users of gas who would accept them. After the rival companies had consolidated the plan was continued, and there were now some 16,000 ranges belonging to the Gas Company in use in that city. These ranges were kept in repair by the Company, and in his paper Mr. Clarke stated how the Company handles those repairs. In the paper the detail of the cost of repairs was given in terms of hours required, but the speaker thought it would add to the value of the paper if Mr. Clarke had given some figures which he had in hand as to the cost of repairs *per stove*. Most of the 16,000 ranges now in use in Kansas City had been in service for about 6 years. During 1901, 5 years after the system was adopted, 2,400 ranges were repaired at an average cost of $2 each, including all of the shop cost. The average cost of shop repairs per stove in use was 33 cents. To this must be added 10 cents per stove for incidental repairs made to stoves in service, for local adjustments, and the like, which made the total cost, for shop repairs and attention to stoves in use, 43 cents per year per stove in service. To this must be added the interest on the investment. The figures kept showed that, taking four prominent makers, without naming the stoves, the cost per stove for repairs ran from $2.19 to $1.50, showing a difference of nearly 40 per cent. in the cost of maintaining one make as compared with that to maintain another make, which was quite an incidental recommendation for the use of the stove which was maintained the cheapest. The figures given were those of actual maintenance cost, including such renewals as had to be made, so that 43 cents per year per stove in use was about what it cost the Company to loan and maintain stoves.

REPORT OF COMMITTEE ON NEXT PLACE OF MEETING.

The Committee on Next Place of Meeting named Detroit as such place, and the recommendation was unanimously adopted.

Mr. R. B. Brown, of Milwaukee, Wis., read the following paper explaining

WHY MILWAUKEE DID NOT BUILD INCLINES.

For a year past the question: "Why didn't you build inclines?" has been asked us so frequently, and by so many different ones, that I finally agreed, at the solicitation of your Secretary, to attempt to detail my answer in the form of a paper to be presented at this meeting.

The question of inclines *vs.* horizontals has been discussed with so much acerbity, and so little real data and actual results have been brought out, so many glaring misstatements have been made, and apparently accepted, on the floors of our Gas Associations, that it does seem to be time we got down to cold matters of fact, divest the inclines of all their glamor, their undoubted theoretical beauty, and consider them from a more practical standpoint.

It will be my endeavor to do this, and if I fail it is to be hoped that the ensuing discussion will more than make good my errors or omissions. The general conditions affecting the carbonization scheme at Milwaukee may be briefly stated as follows:

1. The plant we were called upon to design was to have a maximum capacity of eight million cubic feet per diem of coal gas. The shape and size of our ground (300 feet by 2,000 feet, on which we are obliged to furnish storage for 125,000 tons of coal and 35,000 to 40,000 tons of coke) required the buildings to be arranged very compactly, which necessitated the carbonizing plant being divided and placed in two houses.

2. The nature of our load curve in Milwaukee is such, that (with our ample water gas capacity for an auxiliary and the operation of the old plant in mind), we can at all times operate our new works at or above three-quarters of its maximum capacity.

3. The control of the standard grades of gas coal shipped on the Great Lakes is being gradually acquired by one great combine, and it is well nigh a necessity that we, in order to (in some degree at least),

preserve our independence, be able to use coal from the mines of the independent operators, or from the West Virginia, Kentucky or Illinois fields at will.

4. The price of labor and its attitude to-day, especially in the lower grades, make it advisable to install labor saving machinery to a much greater extent than has hitherto been considered profitable in gas works in this country.

5. We have in Milwankee the field for an exceptionally good coke market, which is now being built up in a very satisfactory manner. So much for the general conditions.

In considering the costs of the various types of bench installations we undertook, first, to estimate the value of each on the basis of first cost, maintenance and depreciation, ground space occupied and operating labor costs; and, second, to arrive, as well as might be, at the relative working results, the advantages and disadvantages, etc., for each system considered.

The types of bench considered were:

1. Free fires (Mr. Chollar's "Big 4's"), as being the most efficient and altogether satisfactory benches which could be built and housed for anywhere near their cost.
2. Inclines, 6's and 8's.
3. Horizontal full-depths, 6's, 9's and vertical 8's.

The free-fired benches were decided to be impracticable for our purposes because of the great difficulty in obtaining and keeping at work the large number of skilled stokers required for hand work, and because of their high fuel account and greater ground area required. These benches were also figured with stoking machinery, which eliminated the first objection; but the fuel consumption and small tonnage carbonized per unit of ground area more than offset the greater fixed charges of the more expensive benches.

For example: 80 benches of "Big 4's" would be required to make 4,000,000 cubic feet per day. The cost would work out about as follows:

House, 490 by 64 by 28	$55,000
Foundations	8,500
Benches	80,000
" foundations	12,500
Connections and drains	5,000
Land at $60 per lin. ft.	29,400
Stoking machinery	32,000
Bins and coal conveyors, breakers, etc	18,000
Total	$240,400

Interest and depreciation at 10 per cent.:

For "Big 4's," as above	$24,040	per annum.
" Inclines (Exhibit B.)	45,334	"
" Horizontals and machinery (Exhibit B.)	33,925	"

The "Big 4's" will use for fuel not less than 25 pounds of coal per 100 pounds coal carbonized, while the other types should not exceed 12 pounds, or a saving of 13 pounds per 100 pounds carbonized, or 260 pounds per ton, or on 100,000 tons (the year's run) no less than 13,000 tons. In Milwaukee the cheapest coal we could use would cost us about $2.50 per ton, or $32,500 per annum, against the free-fired benches from the fuel account alone. Using coke for fuel the difference becomes proportionately greater. This saving in fuel would absorb the difference in the fixed charges on the 2 types of horizontal retort installation 3 times over. If coke conveyors were applied to the free-fired benches, the difference in first cost between the free-fired and recuperative bench would be still less, while if they were not the labor costs would *increase* the economic advantage of the full-depth benches.

Shortage of ground space being one of the difficulties we had to contend with, made it advisable for us to pass over the 6's of both systems.

This narrowed our choice to inclined 7's, 8's or 9's, and horizontal 8's, 9's, or vertical 8's.[1] For comparative purposes we decided on the usual settings of 7's or 8's for the inclines as being the most thoroughly worked out and generally satisfactory of the existing settings.

In horizontals the "vertical 8's" are simply and easily operated, give very even distribution of heat and long life of setting, due to their large open combustion chambers. Their fuel account is low, and ground space occupied small.

Nines, on the other hand, require constant care to maintain even approximately uniform heats, and the excessive localization of heat, because of their small combustion chambers, results in shorter life of settings and requires heavier and more expensive construction. We chose the vertical 8's as giving us, in short, all the advantages of 6's and 9's, without any of the disadvantages of either.

1. The term "vertical 8's" is used to designate a bench setting, 2 retorts wide and 4 high.

Incidentally, the vertical 8's, as designed for Milwaukee, will have several other advantages over the construction common in this country. The layout of ascension pipes is freer, the furnace is sufficiently drawn to the front to allow it to be filled without the need of "stoking back," and our system of recuperation allows for expansion and contraction without liability of creating leaks between air and gas flues and for the ready cleaning of *all* flues from the *front*.

In estimating the costs of the two types of benches (inclined 8's and vertical 8's) it was found necessary to figure all bills of material and construction costs for ourselves, in order to insure the figures being upon the same basis.

In Exhibit "A" I have assumed the life of domestic retorts and settings at 900 days, both for inclines and horizontals. Very little reliable data as to the life of inclined retorts is available, but the best information which I was able to obtain in England was to the above effect. This assumption has been very opportunely confirmed recently by Herr Mers, of Cassell, on data obtained from a number of works in Continental Europe. (See *Journal of Gas Lighting*, Sept. 9, 1902.)

As to the gas made per bench, that assumed for the inclines I believe to be in excess of any average results now being obtained anywhere; while for the horizontals the make allowed is being equalled at Racine, Wisconsin, on all hand work, and, if I mistake not, greatly exceeded at Point Breeze, Philadelphia, by machinery.

Costs of resetting are figured from the bills of material at present prices for St. Louis material at Milwaukee, and labor for the inclines at the same rate per 100 pounds material set, which it is now costing us at our old works, in resetting our old nines,[1] taking into consideration that there are two sets of mouthpieces to be refitted and reset on the bench of inclines.

EXHIBIT A.—*Working Capacity of* 4,000,000 *Cubic Feet per Day.*

	Inclined 8's, 1 Bench.	Horizontal 8's, 1 Bench.
Make per bench, per 24 hours	135,000 cu. ft.	90,000 cu. ft.
Life per bench	900 days	900 days
" in cubic feet made	121,500,000 cu. ft.	81,000,000 cu. ft.
Cost resetting	$1,250.00	$550.00
" " per 1,000	$.0128	$.0068

In Exhibit "B" I have tabulated the first costs of total retort house installation, for a working capacity of 4,000,000 cubic feet per day for inclines, and for horizontals with compressed air stoking machinery, respectively.

The figures given for the horizontal house with machinery are actual, and those for the incline house were figured at the same rates we are actually paying for the other work on quantities taken out from very complete drawings submitted to us by various firms who wished to build inclines for us. The incline bench costs were figured from the quantity sheets of one of the prominent manufacturers abroad, at our prices.

EXHIBIT B.—*Working Capacity of* 4,000,000 *Cubic Feet per Day.*

	Inclined 8's, 32 benches. 4 stacks of 8 benches each, house 474 ft. x 50 ft. x 48 ft., 24,000 sq. ft.	Horizontal 8's, 48 benches. 2 stacks of 24 benches each, house 350 ft. x 72 ft. x 48 ft., 25,000 sq. ft.
Cost of house for 4,000,000 cubic feet per day capacity, including stage floors	$106,000.00	$85,000.00
Building foundations, on piles	7,500.00	6,000.00
Coke conveyors	12,500.00	15,750.00
Coal elevators, conveyors and breakers, 50 tons per hour capacity, each	15,000.00	15,000.00
Charging apparatus for inclines, 96 sets	9,600.00	
2 sets stoking machines, piping and compressor	.....	32,000.00
Bins, 30-hours supply	12,500.00	6,000.00
Benches	249,600.00	144,000.00
Bench foundations, on piles	9,200.00	10,500.00
Connections and drains	3,000.00	4,000.00
Totals for 4,000,000 per day house	$424,900.00	$318,250.00
Land at $60 per lineal foot applies to Milwaukee only	28,440.00	21,000.00
	$453,340.00	$339,250.00
Interest at 5 per cent	22,667.00	16,962.50
Depreciation at 5 per cent	22,667.00	16,962.50
	$45,334.00	$33,925.00
	Cubic feet.	Cubic feet.
On make of 250 maximum days	1,000,000,000	1,000,000,000
Or cost per 1,000 made for interest and depreciation	$.0453	$.0339

1. It is not at all probable that the labor per 100 pounds of material set will be as low in inclines as for horizontals, but I give them the benefit of the doubt.

Note.—10 per cent. interest and depreciation at rate of $.00001 per 1,000 made per $1,000 of first cost.

The slight variations in design and construction met with in practice will not materially alter these figures if computed at prices current to day in Milwaukee.[1]

As the first house at Mariendorf was built for 32 benches of inclined 9's, it will be of interest to note its cost as shown on Exhibit "C." The construction is rather light, and while materials were very high for Germany at the time, yet it will be noted that they are low as compared with present Milwaukee prices, especially as to brickwork.

EXHIBIT C.—*Mariendorf, 32 Benches 9's.*[2]

Costs:	
House, stage floors, etc.	$73,700
32 benches	195,525
Hoppers	17,500

Structural iron, cost at rate of about $62 per ton; tank work, at $70; cost brickwork, etc., $7.75 per 1,000 laid.

As to labor costs for inclines (Exhibit "D."), we took data as to men employed and coal carbonized on the spot, in 8 apparently successful inclined retort installations in England and on the Continent, and revised them to meet Milwaukee conditions at Milwaukee prices for labor.

Note.—Labor costs Mariendorf works, at Milwaukee rates for labor, based on operation of 46 inclined 9's.

EXHIBIT D.—*Labor Costs Inclines, for 32 Benches of 8's.*

Men per Shift.	Men per 24 Hours, 2 Shifts.	
6 Chargers	12 men, at $2.50	$30.00
10 Dischargers, pipe men, etc	20 men, at 2.50	50.00
2 Top men	4 men, at 2.25	9.00
1 Patching, scurfing, etc. (day shift only)	1 man, at 2.25	2.25
2 Clinkerers, 1 at $2.50	2 men, at 2 50	
1 at 2.00	2 men, at 20.0	9.00
1 Foreman	2 men, at 3.25	6.50
22	43	
Oil and minor repairs to charging apparatus and stoppers		3.50
Labor and expense, 24 hours		$110.25

4,000,000 cubic feet made = ... $.0275 per 1,000 cubic feet made.

Or on basis of number of men doing same work on—

46 benches of 9's, at Gitschiner Strasse works, Berlin =	$.0292 per 1,000
At the new works at Vienna, exclusive of coke men	.0310 "
" " Mariendorf works, Berlin	.0280 "
" Chemnitz	.0350 "
" Shoreditch Station Gas Light and Coke Co., London	.0267 "
" Salford	nearly .04 "
" Nottingham	.0370 "
" Lower Sydenham (Crystal Palace)	.0325 "

		Twenty-four Hours.
2 Foremen	at $3.25	6.50
58 Stokers	at 2.50	145.00
5 Clinkerers	3 at $2.50, 2 at 2.00	11.50
4 Pipe jumpers (top men)	at 2.25	9.00
Oil, waste, repairs to stoppers, etc		4.00
		$172.00

Make at 11,000 cubic feet per 2,240 pounds, equal 6,280,000 cubic feet per 24 hours, or $.0280 per 1,000 made.

EXHIBIT E.—*Labor Costs, Horizontals, for 48 Benches of 8's.*

Men per Shift.	Men per 24 Hours. 2 Shifts.	
4 Machine men	8 men, at $2.75	$22.00
8 (1 to 6 benches) lids, pipes, stoking furnaces and cleaning up floor	16 men, at 2.50	40.00
2 Top men	4 men, at 2.25	9.00
1 Scurfing and patching	2 men, at 2.25	4.50
3 Clinkerers, 2 at $2.50	4 men, at 2.50	
1 at 2.00	2 men, at 2.00	14.00
1 Foreman	2 men, at 3.25	6.50
19	38	
Oils, waste and minor repairs to stoking machines and compressor		7.50
Steam for 300 feet free air per minute, compressed to 100 pounds for 12 hours in 24		5.00
Attendance on compressor		1.50
Labor and expense for 24 hours		$110.00

4,000,000 cubic feet made ..... $.0275 pr. 1,000

On basis of number of men employed by Mr. Tysoe, at East Greenwich, in 1901, this becomes	.0232 "
Or, on basis of number of men employed at the No. 4 house, Beckton	.0246 "
Or, on basis of number of men employed at Schöneberg works, Berlin, with Arrol-Foulis machines (Exhibit "G")	.0482 "

For the labor costs on horizontals with machinery (Exhibit "E") I have not taken the *best extant*, as shown at the No. 4 house, at Beckton, the new houses at East Greenwich, or at the Tradeston or Dawsholm stations at Glasgow, but rather, to be on the safe side, have used our own practice in the old house at Milwaukee as a basis on which to figure the work per man for all but the machine men, and figured them as doing 80 per cent. of what is regularly done over there. We must confidently expect to do *better* than this. I *know* we can do as well.

In all these labor costs I have purposely neglected the coal or coke handling costs, as they in no way affect the comparison and are in themselves dependent solely and only on the layout of the works and apparatus employed.

The summary of these figures (Exhibit "F") shows where we landed on the incline question at Milwaukee:

EXHIBIT F.—*Summary.*

	Inclines.	Horizontals.
Exhibit "A."	$.0128	$.0068
" "B."	.0453	.0339
" "D." and "E."	.0275	.0275
Totals	$.0856	$.0882

You have seen more elaborate comparisons on similar lines which did not result the same; notably, Mr. Edward Drory's very painstaking tabulation of the results from the three works at Berlin. To make clear the reasons why Herr Drory's conclusions rightly vary from mine, I must digress somewhat from the direct line here to note some important differences in his conditions, viz.: Different machinery and seemingly excessive number of pipe and lid men.—Exhibit "G."

When Mr. Drory attempts to analyze the working of the various works at Berlin, using the old Foulis machine worked houses for comparison, as against his well nigh perfect inclines at the new Mariendorf works, his figures lose all interest for my purposes.

No one who has seen the Arrol-Foulis hydraulic machinery in operation in the same or adjoining retort houses with the West compressed air machinery, as they can be seen and readily compared by anyone at Leeds, Beckton or East Greenwich, could fail to be impressed with the fact that the Foulis machines were not on the same basis as to the quantity of work per man, and their maintenance is stated to cost more per *machine*, besides correlative disadvantages arising from their method of charging.

In Mr. Drory's paper, published in the *Journal of Gas Lighting*, February 25, of this year, he states the coal carbonized per man employed in retort house per day with his Arrol-Foulis stoking machinery and Hasse-Didier generator furnaces, at 3.85 short tons. Now, many well-managed retort houses in this country, with all hand labor and half or full-depth generator furnaces, will show results close to 3 tons per man, so that it is obviously absurd to use such results as these for comparisons with modern inclined installations.

His retort house labor costs per thousand feet made work out as follows, excluding all coal and coke handling:

EXHIBIT G.—*Schöneberg Works, Berlin.—Arrol-Foulis Stokers.*

4 Foremen	at $3.25	$13.00
20 Machine men	at 2.75	55.00
30 Helpers	at 2.25	67,50
10 Clinkerers, 5 at $2.50		
5 at 2.00		22.50
56 Pipe men, lids, etc	at 2.25	126.00
2 Pump men	at 2.00	4.00
Repairs, etc., oil and waste		15.00
Make of		$303.00

6,280,000 cubic feet per 24 hours, or $.0482 per 1,000.

1. Structural steel, $75 per ton; tank steel, $100 per ton; face brick, $11; common brick, $8.50; Portland cement, $2.50; broken stone, 90 cents a yard; sand, 55 cents a yard; lime, 65 cents a barrel: mason labor, 50 cents per hour; castings, 2½ cents, etc.

2. E. Drory; *Journal of Gas Lighting*, Feb. 29, 1902.

3. E. Drory; *Journal of Gas Lighting*, Feb. 25, 1902.

If I could not have seen my way clear to obtain better results with horizontals and machinery than those stated for his machine worked houses, we without question would have found some other solution for our problem. In looking over a number of moderate sized inclined installations in England, and conversing with some of the engineers responsible for their erection and operation, I was much impressed with the aptness of an expression made use of by one of the "inclined" engineers, and quoted by Mr. Charles C. Carpenter, the well known engineer of the South Metropolitan Company, that "Men who built inclines burned their boats." As soon as you try to get any actual information or data from them, most of these men assume the defensive, and in cases where the number of men employed and their duties have been stated, when giving retort house labor costs for inclines, the costs so figured are almost invariably higher than those stated off hand at the meetings by other men who do not give details of what their costs include. However, I believe that the tabulation of retort house labor for a house of 32 benches of inclined 8's, given under Exhibit "D," is fairly correct. The cost as there figured when compared with hand working is very low, but when compared with machine working under the best conditions, or even with the quite remarkable results obtained by Messrs. Paterson, of Cheltenham, and Lewis, of Wellingboro, with manual machines, the inclines lose their advantage, and we have to look to some other comparison between the two methods of working for justification of the inclined bench under these conditions.

We do not find it in the *fuel* account, for many of those who are now using and advocating these benches frankly state that they use more coke per 100 pounds of coal carbonized than do the horizontals with which they have had experience.[1]

One of the advantages claimed for inclined retorts, the *greater make* of gas for the same *area of ground* occupied, while technically true is very misleading. A retort house, if built for a double stack and with room enough to make the stages habitable in hot weather, will require scarcely any less room than for the back-to-back construction of horizontals. If built in a single house, the ground space required, as shown on Exhibit "B," is also practically the same as that called for by our construction with a double stack of vertical 8's back-to-back. Moreover, in our house we have provided for cross tracks and turntables for the machines at one end of the house, for a 20-foot space at the center of the building between the stacks, to receive the tar overflow apparatus and coke and coal conveyors, and for over 30 feet at the other end of the building; while in the incline house there has been allowed a uniform space of but 10 feet between stacks and at the ends of the house.

I think those who have really investigated this subject and gone into its details at all will agree with me that the 50 feet allowed for the width of this hypothetical single stack incline house is none too great, although inclines have been built and operated in narrower houses.

The "lightening of the stoker's burden" is a favorite theme in these days, but to work in the fierce heat on the stages of many existing inclined retort houses is far more burdensome than even the old-fashioned shovel work. The heated air traveling up the face of the stack, together with the hot blast from the open retorts, needs room to get out—the men need room to stand back—when they can.

There is another point which I earnestly believe has a very great effect upon the yield of gas per pound and on its quality; namely, the shape of the cross section of the charge and the way it is put into the retort.

Some years ago at Newark, where we charged by hand with scoops, I proved, to my own satisfaction at least, that when the scoops were alternately turned in opposite directions, leaving the charge higher against the walls of the retort than in the center, we could (all other conditions being the same) get a better yield than when the scoops were turned all one way, leaving the coal higher in the middle than at the sides. With some coals this difference was more marked than with others, but there was always a difference.

The increased yield I attribute to the smaller depth of partially coked coal which the gas must pass through; the higher candle power and slower growth of carbon to the greater protection of the escaping gas from the highly heated walls of the retort. The first contention seems to be borne out by Mr. Earnshaw's experience with the slice bar in his "high center" charges at Point Breeze, and by the statement made to me at one works in England that they got a better yield from the house worked by West machines than from those worked by the Foulis, though this may be partly due to the loss of gas from the slower operation of the Foulis charger, and also to the fact that this machine packs the coal more or less in the retort, while the West charger rolls it lightly into the corners of the retort, leaving (under my theory) the ideal charge. This form of charge cannot be obtained with inclines.

The make of gas per ton with inclines is claimed by no one to be greater than that made by horizontals under equally good conditions, and many statements and claims are made to the contrary.

The adaptability of inclined retorts for the use of any and all kinds of coal, and any and all sizes of coal, wet or dry or as it may come, is open to serious doubt, and Mr. Carpenter, of the South Metropolitan Company, is not the only engineer in England who openly states that there are only a few coals out of the many they have there which will be found to give entirely satisfactory results in inclines of any construction. I have confidential information that two of the best operated and apparently most successful plants in England are now using selected coal, screened at the pit mouth to their own specification as to size, and paying for the same an additional price per ton amounting in one case to no less than 29 cents. We consider that this is a very important point for Milwaukee; that, in view of the variable conditions which we will have to face in the buying of coal in the next 10 years, we should be able to use any and every grade of coal which will produce satisfactory gas, and of course it goes without saying that we should be able to obtain the utmost possible results out of each grade, and that, so far as is practicable, without making serious changes in our apparatus or machinery when shifting from one grade or kind of coal to another.

Before concluding I would like to state my objections to the very common statement that an incline house can be worked at full efficiency down to two or three benches, while machines are not justified when operated at anything below their full capacity. The engineers who argue thus can indeed lay off men in almost exact proportion to benches, but they forget that the much higher interest, depreciation and maintenance accounts go merriiy on.

To illustrate, let us take these same houses and operate them at one-half their capacity. Charges "A" and "B" remain the same whether the house is working full or not. "D" becomes, for one-half the house working:

Inclines.—16 Benches.—24 Hours.

6 Chargers	at $2.50	$15.00
10 Dischargers, etc	at 2.50	25.00
2 Clinkerers	1 at 2.50, 1 at 2.00	4.50
2 Top men, patchers	at 2.25	4.50
2 Foremen	at 3.25	6.50
Oil and repairs		1.50
		$57.00

at 2,000,000 cubic cubic feet made per 24 hours = $.0285 per 1,000 made.

"A."	.0128	"
"B."	.0453	"
Or a total for operating labor, interest, depreciation and maintenance of	$.0866	"

"E," for one stack working:

Horizontals.—24 Benches.

4 Machine men working "round the house"	at $2.75	$11.00
8 Lid, pipe and furnace men	at 2.50	20.00
2 Topmen	at 2.25	4.50
1 Patcher	at 2.25	2.25
3 Clinkerers	2 at 2.50, 1 at 2.00	7.00
2 Foremen	at 3.25	6.50
Oils, waste and minor repairs		5.00
Steam and attendance		3.50
		$59.75

at 2,000,000 cubic feet made per 24 hours = $.0298 per 1,000 made.

"A"	.0068	"
"B"	.0339	"
Or a total for operating labor, interest, depreciation and maintenance of	$.0705	"

Now, it would scarcely be good practice to install machines in such a manner that they would *never* be operated at more than one-half their capacity, yet even under such unfavorable conditions the high fixed charges of the inclines give machines a more than equal chance.

1. Mr. Herring, 12½ pounds coke per 100 pounds coal carbonized. Mr. Hack's new Nechell's installation, 4 per cent. more than horizontals, etc.

A careful review of the hard, cold facts as I see them can lead to no other conclusion than this. Where conditions are such as to allow of the use of modern stoking machinery, the inclined retort system to-day is not an economic success; and, to quote a very successful engineer on the other side who has exhaustively studied the subject, "They are expensive to erect, difficult to repair, incapable of being worked by hand in the event of a breakdown in the machinery or unsuitable coal having to be dealt with; give a lower yield of gas per ton, depreciate the illuminating power, are uncertain in producing capacity, and more trying to the workmen than horizontal retorts with manual or power stoking machinery."

[To be Continued.]

Gases Used Industrially as Fuels.

The London *Journal* printed in its issue for October 21st the following abstract translation of an article, on the subject named in the heading, contributed to the *Zeitschrift für angewandte Chemie*, by Dr. Messerschmidt:

Coal gas is distinguished by the presence of hydrocarbons in large quantity which give it its illuminating power. This property, however, is of less importance since the introduction of incandescent mantles. In addition, the improvements in gas engines and in methods of heating, with the lowering of the price of gas supplied for power and heating purposes, have brought about the use of a large quantity of gas for these purposes. In the case of many gas works, more than half the production is thus applied.

Gases produced by the combustion of carbon in air are of great importance. This combustion may take place completely to carbon dioxide (CO_2), as is aimed at in ordinary coal furnaces, or the process may be conducted so that the carbon dioxide is converted by the carbon into carbon monoxide, (CO) giving producer gas—

$$(\alpha)\ C + O_2 = CO_2$$
$$(\beta)\ C + CO_2 = 2CO$$
$$(\gamma)\ 2C + O_2 = 2CO$$

Air consists of 21 per cent. of oxygen and 79 per cent. of nitrogen. Instead of 21 parts of O, we obtain 42 parts of CO; and the gas has the theoretical composition—

CO, 34.7 per cent.; N, 65.3 per cent.

In practice the gas always contains varying quantities of carbon dioxide (2 to 10 per cent.), depending on the temperature of the producer; also 1 per cent. of methane (CH_4), from the bitumen of the coal, and hydrogen up to 6 per cent. by the decomposition of the fuel and from the moisture of the air.

If steam is led in along with the air to the heated coal, power or Dowson gas is formed, which contains a considerable quantity of hydrogen—

$$(\delta)\ C + 2H_2O = CO_2 + 2H_2 \text{ (heat evolved)}$$
$$(\varepsilon)\ C + CO_2 = 2CO \text{ (heat absorbed)}$$

According to the proportion of steam to air and other causes, the composition may vary between the following extremes:

Gas.	Hotter.	Colder.
CO	38 per cent.	22 per cent.
H	10 "	24 "
CO_2	—	12 "
N	52 "	42 "

The gas produced in practice always contains carbon dioxide as well as some small quantities of methane and traces of hydrocarbons.

When coal or coke are heated to a high temperature in an air blast, and the air is turned off and steam blown in, the product is water gas, the theoretical composition of which is: H, 50 per cent.; CO, 50 per cent. In practice, in consequence of incomplete reaction and secondary reactions, water gas always contains carbon dioxide, undecomposed water vapor, methane, and nitrogen. The mean composition of the gas obtained in practice is—

Per Cent.		Per Cent.
H 50		CO 40
N 5		CO_2 5

The reaction is in a very high degree dependent upon the temperature of the generator and the speed of the steam. According to Bunte and Harris, the following quantities of water are decomposed:

Per Cent.		Per Cent.
At 874° C. 8.8		At 954° C. 70
" 861° 48.0		" 1,025° C. 93

Thus the water gas produced at these temperatures has the following composition:

	At 674° C.	At 1,025° C.
H	65.0 per cent.	50.9 per cent.
CO	4.9 "	48.5 "
CO_2	29.8 "	0.6 "

These important results are explained by the large heat absorption which takes place in the reactions—

$$C + H_2O = CO + H_2O,\ 28{,}760 \text{ calories absorbed.}$$

As this heat is taken from the coal, the process is not continuous. The operation of gas making must be interrupted after falling to a certain temperature, and air must be blown in to raise it again to the necessary degree. Thus there are two phases in the operation—the heating blast (air) and the cooling blast (steam).

Of the many processes proposed, the following are the most important: The Humphreys & Glasgow (Lowe), the Strache, and the Dellwik-Fleischer. The first two are distinguished by the method of conducting the hot blast. The gas is produced using a high layer of coal and a low pressure air blast, while the last process is so conducted that the combustion in the hot blast period is complete—*i.e.*, to CO_2.

Coming to the heat relations, according to the older process, we have—

$$C + O = CO.\ 28{,}800 \text{ calories evolved.}$$

To burn 12 grammes of carbon, 16 grammes of oxygen are necessary. The oxygen is accompanied by 52.9 grammes of nitrogen, and 28 grammes of carbonic oxide are formed. If the gases escape at 700° C., they carry away—

$$28 \times 0.248 \times 700 + 52.9 \times 0.244 \times 700 = 13{,}895 \text{ calories.}$$

Thus leaving about 15,000 calories available. By the Dellwik-Fleischer process we have—

$$C + O_2 = CO_2.\ 96{,}960 \text{ calories evolved.}$$

Now, 12 grammes of carbon give 44 grammes of carbon dioxide, and the nitrogen introduced is 105.8 grammes. If the gases escape at 1,000° C., they carry away—

$$44 \times 0.217 \times 1{,}000 + 105.8 \times 0.244 \times 1{,}000 = 35{,}362 \text{ calories.}$$

Thus leaving about 60,000 calories available. In the Dellwik-Fleischer process, therefore, with the same coal consumption, four times the amount of heat is stored up for the production of water gas as is obtained in the older process. The method of working is: Air blast, 1 minute; steam blast, 10 minutes—or per hour, 10 minutes for heating and 50 minutes for gas making. In the other processes only one third of the time is available for the production of water gas. Consequently, the yield of water gas by the Dellwik-Fleischer process is much greater than by the others—2 cubic meters (70.6 cubic feet) of gas being obtained from 1 kilogramme of coke. The price (depending, of course, on the price of coke), including depreciation, interest, cost of labor, etc , is 1.5 pf. per cubic meter. If one concedes further the simplicity of the plant, the ease of working (only one or two men are necessary, even with very large producers), and the general properties of water gas, which may equally well be used for lighting, power, and heating purposes, the name "fuel of the future" is certainly not altogether unjustified.

Water gas enriched with oil is used for direct illuminating purposes, especially in America, where two-thirds of the gas works produce such gas. For carburetting the gas, in the Humphreys & Glasgow apparatus it is passed through red hot fireclay chambers, into which the oil is dropped, and converted into easily volatile permanent hydrocarbons. To heat the chambers, the producer gas made during the hot blast period is used. In Germany, the high tax that is levied on oil prevents this application, but it is used with incandescent mantles, for which it is especially suitable on account of the temperature of the flame, which is higher than that of the other gas flames. This temperature is not only dependent on the calorific value of the gas, but to a very large extent on the volume of the flame and the quantity of air necessary for the combustion. Experiment has shown that an Auer burner supplied with a mixture of 20 per cent. of water gas (calorific value 2,500 calories per cubic meter) and 80 per cent. of coal gas (5,0000 calories per cubic meter) gave a flame considerably hotter than that produced when the burner was fed with unmixed coal gas, notwithstanding that the heating value had fallen from 5,000 to 4,500 calories.

Other practical advantages of adding water gas to coal gas are the remunerative utilization of the coke produced on the works, the simple working of water gas plant (of great value in case of strikes), the speed of starting the producer, and the ease with which its working may be accommodated to the consumption. The advantages of gaseous firing are: (1) Cleanliness, (2) ease of regulation, (3) simplicity of working

and (4) excellent utilization of fuel, in consequence of the possibility of burning it without excess of air. The last named advantage is of very great importance. There is an enormous loss of heat in firing boilers due to the neglect of this factor. With four times the amount of air necessary (*i.e.*, 5 per cent. of carbonic acid in the flue gases, which is not rare), and the temperature of flue gases 300° C., the excess of air alone means a loss of 45 per cent. of the fuel, which loss may, by rational working, be reduced to a smaller proportion.

An Integrating Photometer for Glow Lamps and Sources of Like Intensity.[1]

By Mr. Charles P. Matthews.

In a previous paper, read before the Institute, I described an equipment designed for the photometric study of arc lamps. The most valuable feature of this equipment lies in its ability to yield a value of the mean spherical luminous intensity from a single photometer setting. It is the purpose of this paper to describe an apparatus possessing this same valuable feature, and several others worthy of note, when used for the photometry of the incandescent lamp and other sources of the same order of brightness.

Designed especially for incandescent lamp measurements, the apparatus has several functions, and might have been styled a "universal glow lamp photometer." It is capable of use for all photometric measurements on the glow lamp that do not lie in the province of spectro-photometry. To particularize, it may be used as follows:

1. As a simple photometer for any unidirectional measurements, such as occur in standardizations, ratings and candle power distributions.

2. As an integrating instrument for the direct determination of mean horizontal, mean spherical, mean hemispherical or mean zonular candle power.

3. As an integrating instrument for the direct determination of the spherical reduction factor; that is, the ratio—mean spherical; mean horizontal candle power.

The fact has long been recognized that the only strictly fair basis for the comparison of incandescent lamps is that of the total flux of light emitted, a quantity proportional to the mean spherical candle power. It is possible by altering the configuration of the filament to concentrate luminous flux in particular solid angles at the expense of flux in other angles. Hence, two lamps of equal rated candle power may yield total light flux in quite different amounts. On the other hand, if two lamps have initially the same mean spherical candle power, their relative value is determined simply by their power consumption and sustained candle power. The vexed question of what is the most useful light may well be left to the purchaser, who can select the type of filament best adapted to his own needs. The question is comparable to that which asks: What is the best diet for man?

Of the methods in use in the determination of the mean spherical candle power, the most accurate is that in which measurements are made at equal angular intervals through 180° in a plane passing through the axis of symmetry of the filament, the lamp being rotated meanwhile about this axis. From the readings so obtained, the mean spherical value may be found either by formula or the graphical construction known as the Rousseau diagram.

The method employed in the Franklin Institute tests of 1884 involves the mean of 38-candle power values taken in such directions so as to give a nearly uniform space distribution. The mean of these values is the result sought.

Both of the foregoing methods involve a large number of readings—so large, in fact, that their application to the practical rating or extended study of lamps is out of the question.

A third method consists in the use of the spherical reduction factor appropriate to the type of filament under consideration. Unfortunately, this factor is not a constant for any given type of lamp. With some types, the method yields a good result; with others the variations are such as to render the results only roughly approximate. A disadvantage is the large and increasing number of types on the market and the necessity for determining and keeping account of the corresponding constants.

Liebenthal found as the result of an extended series of measurements that the mean of the intensities taken at 51.8° north polar distance and 51.8° south polar distance on a spinning lamp is a value approximating the mean spherical intensity, regardless of the type of lamp. The errors resulting from the application of this method range from — .1 per cent. to + 3.9 per cent. This is probably the most accurate of the simpler approximative methods.

From what has been said, it would appear that there is need of a photometer capable of giving the mean spherical candle power of an incandescent lamp with the ease and celerity obtainable in the ordinary photometric measurement. With this need in mind, I have designed and had constructed the apparatus described below.

The theoretical basis of the design is the approximate equation for the mean spherical intensity,

$$I_{ms} = \frac{\pi}{2n} \sum_{0}^{\pi} I_\theta \sin\theta \qquad (1)$$

wherein I_θ is the intensity of a ray making an angle θ with a vertical passing through the light center and n the number of terms in the summation. In order that equation (1) may apply to a glow lamp, it is necessary to spin the lamp precisely as is commonly done in determining mean horizontal candle power.

To see how equation (1) may be made the basis of an integrating photometer, let us consider a source of light (Fig. 1), and a photometer screen P, whose plane extended contains the effective light center of S. We will hereafter denote the center of the photometer screen by p, and the effective light center by q. For convenience we will further assume that p and q lie in the same horizontal plane, to which the plane of P is normal, and we will call the line pq the axis of the system. Now consider two mirrors whose planes are vertical and make an angle of 90° with each other. Let the centers of these mirrors, designated by a and b, come into the horizontal plane in such positions that the lines qa and pb are equal and respectively normal to the axis of the system. Let a' and b' be the centers of a second pair of mirrors occupying a position such as would be found by swinging a and b, without mutual displacement, upward about qp as an axis until qa makes the acute angle θ with the vertical. Having thus located a' and b' angularly, we may now assume that some radial movement of this pair of mirrors is possible. The eye placed at p will see virtual images of the source in horizontal and θ aspects, respectively. The images s' and s'' may be regarded as producing jointly an illumination on the photometer screen of

$$i_o + i_\theta = \frac{K_o I_o}{d^2_o} + \frac{CK_\theta I_\theta}{d^2_\theta} \qquad (2)$$

where K_o and K_θ are the reflection coefficients of the pairs of mirrors, d_o, d_θ, the distances from source to screen by way of the mirrors, and C a factor varying with the incidence of the light upon the photometer screen P. Now if n pairs of mirrors be placed similarly to a, b and a', b', but spaced at equal angular intervals of $\Delta\theta$ such that $n\Delta\theta = \pi$, we shall have as the resulting illumination

$$\sum_{0}^{\pi} (i) = \sum_{0}^{\pi} \frac{CK_\theta I_\theta}{d^2_\theta} \qquad (3)$$

If by radial adjustment of the mirror pairs we make

$$\frac{CK_\theta}{d^2_\theta} = \frac{K_o \sin\theta}{d^2_o} \qquad (4)$$

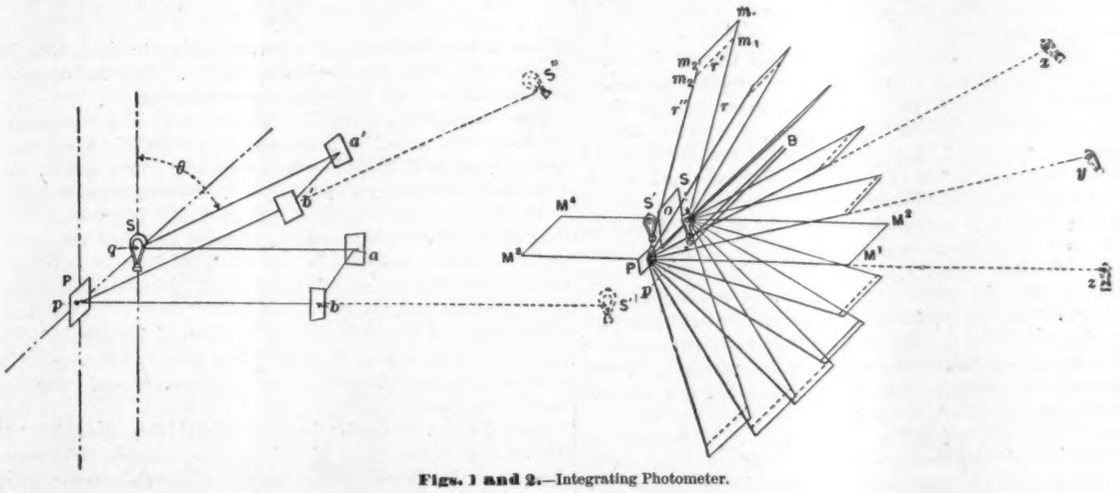
then

$$\sum_{0}^{\pi} (i) = \frac{K_o}{d^2_o} \sum_{0}^{\pi} I \sin\theta \qquad (5)$$

That is to say, the total illumination of the screen is proportional to the mean spherical intensity of the source. (See equation 1.) To evaluate this intensity, it is necessary merely to balance this illumination against that due to a source of known intensity at a known distance.

Fig. 2 shows the disposition of twelve pairs of mirrors, m_1, m_2, etc., in order to produce the desired results. If the illumination of a given surface varied exactly as the cosine of the incidence of the light upon that surface, and if all mirrors used were of equal reflecting power, then there would be no need of radial adjustment of the mirror pairs, for in such case $SC = \sin\theta$ and $K_\theta = K_o$. But the so-called cosine law is only approximately true, and mirrors vary in reflecting power, hence it is necessary to compensate for discrepancies in C and K_θ by slight changes in d_θ. The extent to which this correction is of importance depends, of course, upon the nature of the photometer screen. The plaster of paris surface of the Lummer-Brodhun screen obeys the cosine law with exactness up to an incidence of 50°, but beyond this point a divergence of increasing magnitude occurs (Fig. 3). Hence, for the Lummer-Brodhun screen the only adjustment of mirrors necessary is that to overcome variations in their reflection coefficients, except for angles greater than 50°. With mirrors cut from one sheet of glass, the correction for variation in reflecting power is often negligible. With the Bunsen screen, correction must be made for all angles of incidence. For example, the second curve in Fig. 3 is the result of

1. Read at the last meeting of the American Institute of Electrical Engineers.



Figs. 1 and 2.—Integrating Photometer.

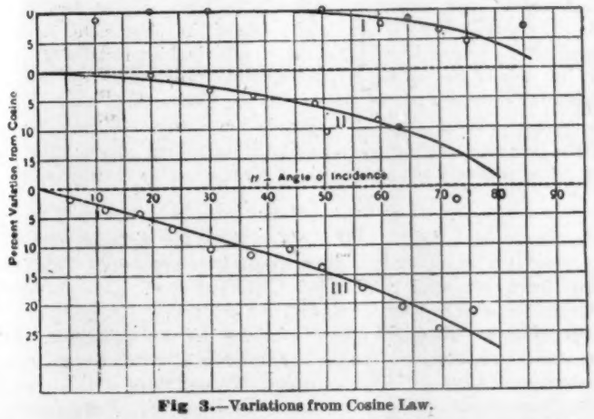


Fig 3.—Variations from Cosine Law.

measurements made upon ordinary draughting paper, from which the Bunsen screen is often made. Here the departure from the cosine relation is noticeable from the very beginning, and becomes as high as 15 per cent. at 75° incidence. The third curve in the same figure shows the results obtained with ordinary glazed writing paper. The cosine relation is not even roughly approximate in this case.

Fig. 2 also shows the method of balancing the illumination produced by the series of images, due to the circular system of mirrors. The curves show the percentage of variation from cosine relation for different screens: Curve I, referring to the Lummer-Brodhun screen; Curve II to a screen of unglazed paper, and Curve III to a screen of glazed paper. Mirrors M_1, M_2, M_3, M_4 are cut from one piece of glass, just as are the mirrors in the ordinary Bunsen photometer. It is not essential that the other mirrors of the system should have the same coefficient, since, as already explained, the initial adjustment corrects for failure of the cosine relation and inequalities in the mirror coefficients at the same time. With the standard at S' separated from S, the source to be tested, by an opaque screen, a balance in the illumination is obtained by moving M_3 and M_4. The method of doing this will be better understood by reference to Fig. 4

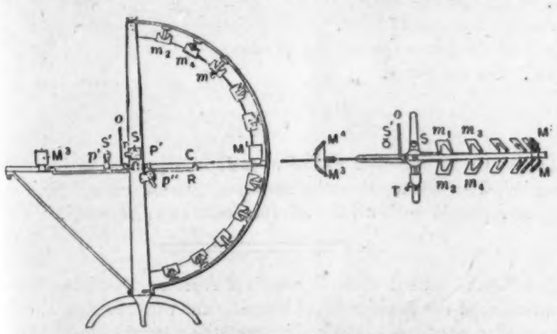


Fig. 4.—Elevation and Plan of Apparatus.

which shows in elevation and plan the essential elements of the apparatus. To the right of these figures is seen the mirror system, each pair of mirrors being capable of a certain amount of radial movement for purposes of the initial adjustment of the instrument. S is the lamp to be tested, mounted upon a rotator, S' is a standardized glow lamp. The mirrors M_3 and M_4, rigidly connected, may be moved along the bar by means of a rack and pinion conveniently under control of the observer at the photometer P. The photometer is fixed, and hence the operation of making a setting is more convenient than that which obtains with the ordinary sliding form. As the design is based upon the approximate equation (1) and not upon the integral form, some error arises from this cause. With 11 pairs of mirrors the error is negligible for all practical purposes.

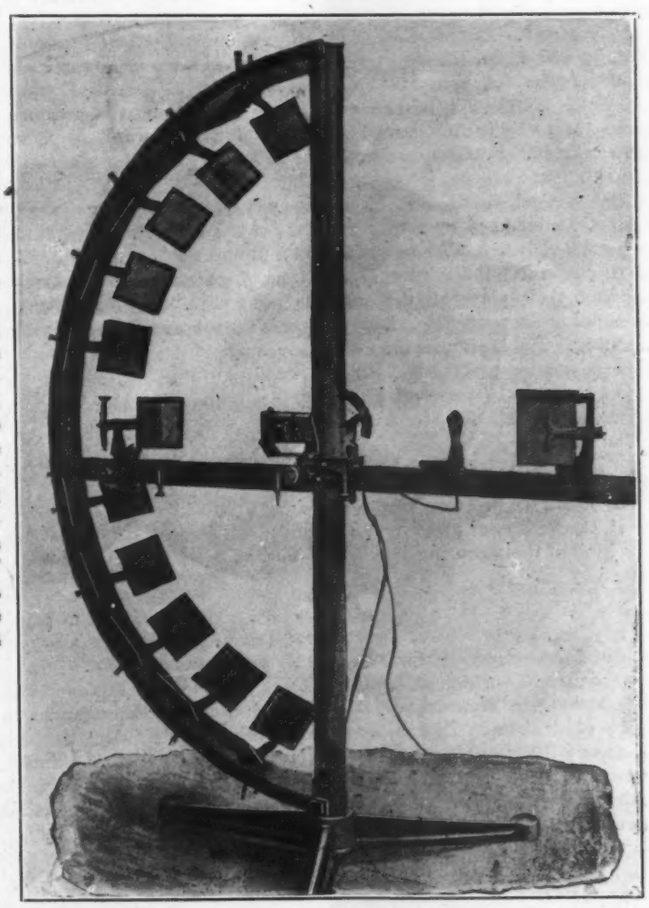


Fig. 5.—General View of Apparatus

Fig. 5 shows a photograph of the finished apparatus with all screens removed, in order that the details of construction may be better seen. This particular instrument is fitted with a Lummer-Brodhun photometer screen. Each mirror bracket is provided with 2 pins. These pins extend through the frame of the ring radially. By means of this constouction, each mirror pair may have independent radial adjustment.

We will now consider in detail the different operations to which the instrument readily lends itself.

Operation 1.—*Measurement of Mean Horizontal Candle Power.*—In this operation the apparatus is used as a simple photometer. Hence, all mirrors except the four horizontal ones are covered by black screens suitably provided for the purpose. The right pair of mirrors (Fig. 4) is connected at C to the sliding rod carrying the rack. The lamp, S, to be tested is mounted in the rotator and driven at a speed of, say, r. p. m., and a standardized incandescent lamp, of intensity $1_s'$ is placed in a suitable holder, at S'. The rod R may be moved by the hand for a rough adjustment, and the pinion P' used only for the final setting. Since a displacement d, of the mirror pairs means a change in the light paths of $2d$, the moving rod is graduated in divisions one-half the unit (centimeters) in which the light paths are conveniently measured. A reading R, means that the distance from S' to the screen by way of the mirrors M_3, M_4, is R centimeters. If now the total photometric distance between the sources is 300 cm, we have for the intensity I of the light under test,

$$I_s = \left[\frac{300 - R}{R}\right]^2 I_s' \tag{6}$$

$$= T_1 I_s' \tag{7}$$

where T_1 is the value of the expression in brackets and stands for "tabulated value corresponding to the reading R." When the apparatus is used with a standard of always the same intensity, it is a simple matter to make the instrument direct reading.

Obviously, the mean intensity in any north or south polar zone may be found by clamping the arm of the rotator at the proper angle and spinning the lamp, readings being taken as for the mean horizontal measurement. The mean horizontal candle power of a flame source must be found by taking the horizontal distribution stepwise, since it is impracticable to rotate such a source. Equation (7) is applicable in such measurements.

Operation 2.—*Distribution of Candle Power in Vertical Planes.*—The distribution of intensity of an incandescent lamp in any vertical plane is obtained with the apparatus arranged as described under Operation 1. The arm of the rotator is merely tilted about a horizontal axis so as to bring any desired aspect of the lamp toward the photometer screen. From equation (7) the different intensities are easily found.

The vertical distribution of candle power from a flame source cannot be obtained by tilting the arms of the support. The following method is available in such cases: Mount the burner vertically at S; disconnect the mirrors M_3, M_4 from the movable rod and push them to their place at the extreme right (Fig. 4). Now with a standard of the same order of brightness as the source to be tested make a setting. The horizontal intensity is given by

$$I_0 = \left[\frac{200}{R}\right]^2 I_s' \tag{8}$$

$$= T_2 I_s' \tag{9}$$

where T_2 is the tabulated value of the expression in brackets corresponding to the reading R.

To obtain the intensity of the source in a direction of θ_0 to the vertical, the horizontal and θ mirrors should both be used. This prevents the limit of the bar being reached by mirrors M_3, M_4. The intensity is given by

$$I_0 = \frac{T_2 I_s' - I_0}{\sin \theta} \tag{10}$$

where I_0 is the intensity found in the horizontal measurement.

Operation 3.—*Standardization of Glow Lamps*—For this operation the lamp S, is removed and a horizontal circular plate mounted in place of the lamp. This plate is ruled with concentric circles, which facilitate the centering on the amylacetate lamp or other primary standard. The lamp to be standardized is mounted at S'. With all mirrors screened except the horizontal ones, and with M_1, M_2 attached to the bar, settings are made as usual. The value of S' is given by

$$I_s' = \frac{1}{T_1} \tag{11}$$

if the standard is unity.

Operation 4.—*Measurement of Mean Spherical Intensity.*—(*a*) *Glow Lamp.*—The lamp to be tested is mounted in the rotator and driven at a speed of about 180 r. p. m. Mirrors M_1, M_2 are detached from the movable rod and pushed to the extreme right, in which position they may be considered a part of the system of eleven mirror pairs. With a standardized lamp at S', a setting is made in the manner already described. If R is the reading, we have

$$I_{ms} = T_3 I_s' \tag{12}$$

where T_3 is a tabulated value corresponding to the setting R and I_s', the intensity of the standard as heretofore. Thus the operation has all the simplicity of any photometric measurement.

The intensity of the standard used should be approximately that of the lamp to be tested. For example, if a 16-candle power lamp is to be tested, a standard of not less than 16-candle power is best. With such a standard, the range of possible measurement depends upon the limit of travel of the mirrors M_3, M_4. A 16-candle power lamp will serve as a standard for the measurement of mean spherical intensities ranging from 2 to about 25-candle power, when the limit of travel is about one meter. It is best to substitute a 32-candle power standard for intensities much greater than 16-candle power.

(*b*) *Flames.*—To obtain the mean spherical intensity of a flame or of any source that cannot be rotated, it is necessary to repeat Operation 4 at equal angular intervals on the horizontal circle. The mean of the results may then be taken.

Operation 5.—*Direct Measurement of the Spherical Reduction Factor.*—If the standard S' and the opaque screen O be removed, it is clear from the figure that the left side of the photometer screen will be illumined by the horizontal rays of the lamp S. In fact, if S be rotated, we will have on the right side of the photometer screen an illumination proportional to the mean spherical intensity of S, and on the left side of the screen an illumination proportional to the mean horizontal intensity of the same source. Under these conditions the photometer setting yields the spherical reduction factor. In other words, the mean spherical intensity is measured against the mean horizontal intensity as a standard. The reduction factor is given by

$$f = T_3. \tag{13}$$

As the removal of the standard S' lengthens the distance from source to screen, it is necessary to add a constant to the reading. This is provided for by a second reading point, marked $R\,F$. All readings for Operation 5 must be taken at this reference mark.

Operation 6.—*To Check the Horizontal Mirror Constants.*—As before stated, it is essential that the four mirrors attached to the movable bar be should have the same constant. To ascertain if this condition exists, remove the opaque screen and the lamp S', as in Operation 5. Connect the horizontal mirrors to the moving rod and, screening all other mirrors, take reversed photometer readings on a rotating lamp S. If the mirror coefficients are equal the mean reading will be 150, indicating equal light paths on each side of the photometer screen. Here again the $R\,F$ reading mark must be used.

Operation 7.—*To Check the Adjustment of the Circular Mirror System.*—In case of any doubt as to the accuracy of the initial adjustment of the photometer, or in case of the substitution of a new screen, it may be necessary to readjust the mirrors of the half ring. This operation is best performed as follows: Mount at S a 32 nominal candle power lamp, and at S' an 8-candle power lamp, the latter being in circuit with a rheostat capable of continuous variation. With mirrors M_1 and M_2 free from the moving rod, and with all other mirrors on the half ring screened set R equal to 100 cm. Now, while maintaining the 32-candle power lamp at constant voltage, vary the voltage impression on the 8-candle power lamp until the photometer shows equal illumination. Note voltage on 8-candle power lamp. Repeat measurements with reversed photometer. The lamp should finally be maintained at the mean voltage so found. Under these conditions the two lamps have a candle power ratio of 4:1. Next tilt the lamp holder to an angle of 15°. Uncover the corresponding mirrors ($\theta = 75°$ or $\theta = 105°$) and cover the horizontal ones. Under these conditions we have the same aspect of the lamp toward the photometer, but with the light incident at 15°. Set the bar at

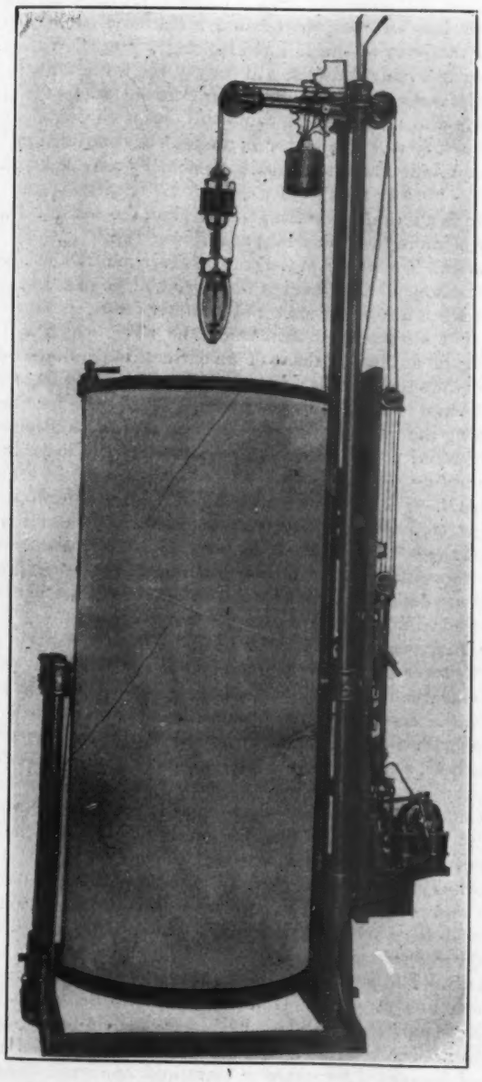
$$R_{15} = \frac{R_0}{\sqrt{\cos 15°}} \tag{14}$$

Adjust the 15° mirrors radially until an equality of illumination is obtained, then secure them by means of the set screw. This operation may be repeated until all the mirrors have been adjusted.

THE Town Council of the Borough of Ambler, Pa., has granted to the proprietors of the Ambler Gas Company the right to pipe the streets for the conveying of gas to the residents of the named place. It is specified that the Company is "To supply the said borough and general public, who may desire to use the same, with gas at such prices as are paid by consumers of gas in boroughs of a corresponding population in Pennsylvania."

Blue Printing by Electric Light.

According to a contemporary, the Eugene Dietzgen Company, of Chicago, is putting on the market an automatic blue printing machine which will be of interest to engineers, not only from its application to the needs of the drafting room, but the peculiar working features of the device. The apparatus consists of a cylindrical printing frame, composed of two heavy curved plates of glass, bedded in soft material in an adjustable, though rigid frame, together with two tubular uprights which support the arc lamp and automatic driving mechanism. This drive operates the lamp, having means for lowering it through the cylinder and then automatically raising it to its former position. The cylindrical frame revolves on trunnions, so that it it can be swung to a horizontal position for inserting or removing tracings and paper from the frame.



In operating, the cylinder is revolved to a horizontal position, and the tracings and sensitized paper are placed around the outside of the cylinder, being confined by stout canvas covers, which are drawn tight by turning a lever, giving complete contact between tracings, sensitized paper and the glass. The cylinder is then swung to the opposite horizontal position and the manipulation repeated, after which it is returned and locked in vertical position and is ready for printing.

By touching a lever the arc lamp is started in its descent through the center of the cylinder at a speed which can be regulated to suit the sensitiveness of paper employed. When the lamp has reached the lowest point of printing surface, it automatically reverses its motion. The downward movement of the lamp can be regulated to take from 5 seconds to 1 hour. When the lamp has passed the printing surface, thereby completing the exposure, the motion of the lamp reverses automatically and returns it quickly to the original position—no time being lost and no hand labor required. The limit of the motion of the lamp can be regulated according to the size of the prints.

It is claimed that the cost of making blue prints by electric light is less, where the full capacity of the machine is utilized, than by the use of sunlight, and with an average allowance made for wasted material under the ordinary method due to over-printing, etc., with attendant loss of time.

Corrosion of Steel Frames of Building.

By Mr. Charles L. Norton.

There can be no question that moisture and carbon dioxide are the active agents in causing much of the rusting of steel. To what an extent the two are relatively responsible and in what measure they need renewal, to keep up the process, is uncertain. It has been held that the formation of a coat of rust upon the surface of steel was the beginning of a progressive action whereby the rust, or iron oxide, acted as a continuous carrier of oxygen to the steel beneath. This process seems to require only moisture and atmospheric air containing carbon dioxide to start it, but as to the depth of penetration of the process I know of no assignable maximum in any given time. It is extremely probable that in a comparatively dry place the process is exceedingly slow.

There can, of course, be no question as to the ease of access to the steel, in many cases, of both moisture and carbon dioxide. When steel is bedded in the wall of the building, as is almost always the case, the changes in temperature from time to time, as well as the more or less constant difference in temperature between the two faces of the wall, tend to cause a condensation of moisure in the wall at different points. Further, the necessary carbon dioxide is most plentiful in the large cities, where the steel frame is most common.

When the walls of the building are of brick or stone, moisture and carbon dioxide may usually enter at the joints and, to a greater or less extent, through the body of the stone or brick. Few stones are, however, porous to such an extent as to allow an appreciable penetration. Terra cotta tile is of itself porous, and the existence of air passages tends to increase the condensation of moisture and absorption by the terra cotta and possible contact with the steel. Concrete, made of Portland cement with sand and either cinders or stone, would seem to offer more protection to the steel than any of the materials just mentioned; yet we hear from time to time of the loss by corrosion of steel bedded in concrete.

A study of the action of Portland cement concrete on steel was begun under my direction by P. C. Pearson in December, 1901, and it is my purpose to report upon this and some later observations as a preliminary to more work of the same nature now under way.

It has been held by several engineers that the mere alkaline nature of Portland cement was a sufficient guarantee of its protecting steel from rusting. There is, of course, good chemical reasoning for this, the familiar use of strong alkaline solution in boilers to prevent the formation of scale being based upon the same principle. This would seem to settle the matter once and for all, were it not a fact that steel bedded in concrete has corroded very rapidly, while other steel in a different concrete of the same kind of cement stands without change for 10 years or more. The investigation was started not to find out that steel could not be protected by concrete or that it could be, for on that point we were sure, to start with, but we have tried to find a reason for occasional failure and to suggest a remedy.

An examination of several cases where expanded metal had been imbedded in concrete showed plainly that rusting began wherever the steel was exposed through cracking, even though the cracks were very fine. It would seem that the alkaline nature of the cement would be sufficient to prevent corrosive action occuring within a few hundredths of an inch on the moist surface of the steel, but such is not always the case.

To study the matter systematically, two brands of American Portland cement, Alpha and Lehigh, were selected; two kinds of cinders, one from the sugar refinery, the other from the Boston and Albany locomotives; a sharp, clean beach sand, and a hard, clean broken stone, the larger part being fragments of flint and trap rock. Concretes were made up in bricks about 3 by 3 by 8 inches, with the steel specimens near the center.

The following mixtures were tried at first; others will be reported on later: Neat cement; cement, one part, to three of sand, one part of cement and five parts of broken stone, and one part of cement to seven parts of cinders. All briquettes were made in duplicate with both cements. There were later made up briquettes of one part of cement to

two parts of sand and five parts of cinders, and of one part of cement to two of sand and five of crushed stone.

It was hoped to vary the density, the porosity and the nature of the contact with the steel, as well as the chemical composition of the concretes. The cements were tested chemically and physically and found good. The cinders, when washed down with a hose stream and dried, tested distinctly alkaline, and analysis revealed very small amounts of sulphur. The stone and sand were thoroughly washed and clean. The ingredients were mixed dry in every case and, when wet, thoroughly mixed and tamped until wet on top.

The cleaning of the steel was the most troublesome problem met with. It was necessary to scour the pieces, then pickle in hot dilute sulphuric acid, and finally dip into hot milk of lime. When cold the lime was removed with a wire brush This left the steel clean and bright, ready to be put into the test bricks.

The specimens used were a mild steel rod 6 inches long and ¼-inch in diameter, a piece of soft sheet steel 6 x 1 x 1/32-inch, and a strip of expanded metal 6 x 1-inch, all three pieces being put in each brick. Since time would not permit of our exposing these specimens to natural conditions, we inclosed them in several large tin boxes, sealed tightly and subjected one-quarter of them to an atmosphere of steam, air and carbon dioxide, and second quarter to air and steam, a third to air and carbon dioxide, and a fourth stood upon the table of the room, with no special care as to their temperature or dryness. Of the entire number about one-half were set in water for one day, the rest for seven days, before sealing up. At the end of three weeks the briquettes were carefully cut open and the steel examined and compared with specimens which had lain unprotected in each of the tin boxes. Those specimens which were mixed of neat cement can be dismissed without discussion, for the protection was perfect. The steel was as bright as when put in. The unprotected pieces were found to consist of rather more rust than steel. The steel was wrapped about pieces of uralite, to serve as a means of identifying it by number, the stamped numbers being nearly obliterated by the rust. Of the remaining specimens hardly one had escaped serious corrosion. The location of the rust spot was invariably coincident with either a void in the concrete or a badly rusted cinder. In the porous mixtures the steel was spotted with alternate bright and badly rusted areas, each clearly defined. In both the solid and the porous cinder concretes many rust spots were found, except where the concrete had been mixed very wet, in which case the watery cement had coated nearly the whole of the steel, like a paint, and protected it. Some briquettes made later of finely ground cinders and cement, in varying proportions, when exposed to moisture and carbonic acid, showed how effectually the presence of cement prevented rusting, even in a highly porous mass—one cement to ten of cinder—provided there were no cracks or crevices or distinct voids.

From the examination of these several hundred briquettes we were able to draw several conclusions:

1. Neat Portland cement, even in thin layers, is an effective preventative of rusting.

2. Concretes to be effective in preventing rust, must be dense and without voids or cracks. They should be mixed quite wet where applied to the metal.

3. The corrosion found in cinder concrete is mainly due to the iron oxide, or rust, in the cinders and not to the sulphur.

4. Cinder concrete, if free from voids and well rammed when wet, is about as effective as stone concrete in protecting steel.

5. It is of the utmost importance that the steel be clean when bedded in concrete. Scraping, pickling, a sand blast and lime should be used, if necessary, to have the metal clean when built into a wall.

In the matter of paints for steel there is a wide difference of opinion. I cannot believe that any of the paints of which I have any knowledge can compare with a wash or painting with cement. Moreover, if paint does disintegrate, it leaves a thin void next the steel, the worst possible condition. I examined some steel Z bars not long ago which were exposed in process of altering a building five years old. It was clear that the steel was rusty when painted and that moisture had penetrated through the paint, caused the rust to increase and split off the paint. This was a case where the steel was built into the brickwork with no attempt at any protection other than the paint.

It is, in my opinion, perfectly clear that the coating of all steel work with cement before applying the concrete or tile or brick, as the case may be, is an absolute essential, if the formation of rust and consequent weakening of the steel are to be prevented. The thickness of the cement layer need not be great, but it should be a continuous coating, without cracks. The steel should be perfectly clean; but if, as is often the case, the choice is between paint and rust which accumulates during construction, the paint is to be preferred. Mr. Pearson suggested the use of Portland cement in protecting the underside of railroad bridges against rust and the blasting action of the gases and cinders from locomotives. I think this merits a careful trial.

A New Western Power Plant.

Electricity says that the general plan of the White river power development by the Snoqualmie Falls and White River Power Company will be to divert the water of White river at a point in the southwest quarter of Section 35, Township 20, North Range, 6 East, in Pierce County, State of Washington, and to convey the waters thus diverted through an excavated canal, a distance of about 8 miles, to Lake Tapps. The level of this lake will be raised until it occupies an area of about 5,000 acres and will serve as a storage reservoir and settling basin. The outlet of this lake will be a short canal and tunnel connecting with a penstock on the brow of the hill overlooking the Stuck Valley. Steel pipes leading from the Penstock will convey the water under a head of 450 feet to the water wheels in the power house at the foot of the hill; and from the water wheels the water will escape through a short tail race into Stuck river. The power house will be connected in with the present Snoqualmie Falls transmission system by circuits about 5 miles in length.

The above is an outline of the general plan, the several features of which may be more fully described as follows:

Head Works.—The intake at the point of diversion will be constructed of concrete masonry. The level of the river will be raised at this point in order to effect a full entrance of the water into the intake by the construction of a submerged dam across the river, which will be continued to the intake in the shape of an earthen embankment designed to be higher than the river at any stage There will also be constructed at the intake and in connection therewith, a set of gates for the purpose of discharging the water back into the river and in shutting the same off from the canal at any time it may be desired to do so for inspection or repair purposes.

Inlet Canal.—The canal throughout its entire length will be a thorough cut through earth and cement gravel. The canal will be 25 feet wide on the bottom with side slopes of 1½ to 1 below the water line and 1 to 1 above the water line and will flow 6 feet deep. The canal and intake are designed to discharge a volume of water equivalent to 60,000 theoretical horse power under 450 feet head.

Storage Reservoir.—The contour of Lake Tapps is such that the raising of its level would overflow the lake at eight different points, but this is to be prevented by the construction of earthen dams at these particular points. Aside from these dams the only work to be done in connection with the reservoir is to clear about 1,000 acres of land around the lake, and to build a ditch to connect Church Lake with this storage reservoir.

Outlet Canal.—This work consists of a canal having the same design as the Inlet Canal, and the construction of a tunnel which is a prolongation of the Outlet Canal.

Penstock.—The penstock is designed to receive the full discharge of the canal and which will be constructed of concrete masonry. The penstock will have five outlets through which will be discharged the water to the different pipe lines.

Pipe Lines.—The present development contemplates the installation of one pipe line at present, sufficient in size to deliver 10,000-horse power. More pipe lines will be added later as additional water wheels are installed. The pipe lines will be of rolled steel plates riveted together and supported by concrete piers and anchored firmly to the earth.

Power House.—The power house is designed to accommodate a 50,000-horse power installation of water wheels, generators and accessories. The building will be erected in common red brick, although at present it will be erected in part only, sufficient to house a 10,000-horse power installation of water wheels and generators. As an adjunct, there will be a machine shop equipped with a lathe, drill press, shaper and blacksmith forge with the necessary accessories. There will be installed in the power house two 3,000 kilowatt generators and two exciters of the Westinghouse type, directly connected to impact water wheels of sufficient capacity to drive the generators under full load.

Transformer House.—There will also be erected either separately or in connection with the power house a transformer house in common red brick, and there will be installed therein 10,000-horse power of raising transformers.

Company Building.—A frame building will also be constructed near the power house for the purpose of housing the men who will operate the plant and which will also contain a dining room, kitchen and laundry; and rooms for office, store and drafting purpose.

Correspondence

[The JOURNAL is not responsible for the opinions expressed by correspondents.]

Mr. Egner Returns to the Charge.

BALTIMORE, MD., Nov. 3d, 1902.

To the Editors AMERICAN GAS LIGHT JOURNAL:

It is to be regretted that, in the letter of Mr. A. E. Forstall, of the 28th ult., published in your issue of even date, he takes advantage of a phrase I purposely employed in my letter to you of the 18th ult., viz., "At least, that is what I understood him to say," to give him an opportunity to make such an explanation (?) as to force me to reply to him; and to state that he now seems to raise a question of veracity concerning an interview to which there were unfortunately no witnesses within hearing distance.

Mr. Forstall said in effect just what I stated, and I now withdraw the phrase I used of my own as above quoted. Mr. Forstall, in the course of the conversation, which I distinctly recollect almost if not entirely verbatim, asked me, "Then, why are they going to put stoking machines into the largest coal gas works in America?" On my asking where this was, he replied, "At Milwaukee;" but he did not say anything about a paper to be presented on the subject, and did say that he regretted not to have called for a paper on the inclines. It was that statement of his which made me prepare a question for the Question Box, calling for information not previously published on the subject of inclines. That question I withdrew at Mr. Forstall's suggestion, after the reading of the President's (Mr. Beal) address and the certainty of a presentation of a paper by Mr. Brown. Why was that paper not distributed until just before the reading of it, on the second day of the meeting? And if Mr. Forstall "could congratulate himself" on "having practically secured" this paper, on the morning of the 6th of October, then why was no notice given of the subject until the programme was distributed on the morning of the first day of that meeting? Certainly I saw none, and I reside but a short distance from New York city.

Mr. Forstall is mistaken about his "recollections" when stating he "Thought the paper would lead to a lively discussion." He said nothing of the kind to me. I am not interested in inclined retorts any more than any other gas engineer. I was so, for only the space of one year, while engaged with the Laclede Firebrick Manufacturing Company. After I have devoted much time, money and study to the subject, I am not interested in preventing the use of stoking machinery, whenever and by whoever such may be desired.

Of course, that question has not been raised by Mr. Forstall at all; and I only mention it to emphasize my position as a gas engineer in the matter of an improvement of such note as that of the inclined retort system, through which others now are about to be benefited, while the writer has only the poor satisfaction to know, that time and results have shown him to have been on the right side of the question 12 years ago and all along. The inclines have come to stay, despite of Milwaukee's preference for stoking machinery.

Very respectfully,

FREDERIC EGNER.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE plant and franchises of the Keokuk (Ia.) Gas Light and Coke Company have been purchased by the Keokuk Street Railway and Power Company. The latter concern has been operating an electric lighting plant for some time.

THE Galion (O.) Gas Light Company has increased its capital stock from $35,000 to $100,000. President Blake says that the plant will be reconstructed.

MR. W. C. EDSON, as Secretary of the concern, has applied to the authorities of Storm Lake, Ia., for a franchise under which the Storm Lake Gas Company proposes to operate. It is specified that the initial capital stock shall amount to $25,000.

AT the annual meeting of the Buffalo (N. Y.) Gas Company the Directors elected were: Alex. C. Humphreys, Henry Seligman, R. C. Pruyn, Stephen Peabody, J. Edward Addicks, Howard L. Clark, P. P. Pratt, R. L. Fryer, Franklin D. Locke, H. T. Ramsdell and Wm. S. Riseley.

MR. FRANK D. MOSES says that the 12-inch, wrought iron, high pressure main, connecting the works of the South Jersey Gas, Electric and Traction Company, at Trenton, N. J., with the Company's plant at Camden, N. J., was satisfactorily put at work the morning of the 2d inst. The initial pressure carried was 22 inches, and the trial run of the first 24 hours resulted in the transporting of 200,000 cubic feet of gas from Trenton to Camden, a distance of 42 miles, without a hitch. The maximum delivery that can be relied upon for 24 hours is 3,000,000 cubic feet, carried at a pressure of 25 to 30 pounds. The line was tested up to 65 pounds, and was found to be absolutely tight. Naturally, Mr. Moses is quite elated over the success that attended the completion and putting into commission of the largest stretch of high pressure pipe in America devoted to the transmission of artificial gas.

THE shareholders of the East Boston (Mass.) Gas Company have authorized an increase in the capital stock, from $220,000 to $275,000. The price and amount of stock, to be finally issued, however, will eventually be determined by the State Board of Gas and Electric Light Commissioners.

THE regular quarterly dividend of 2 per cent. on the stock of the Brooklyn Union Gas Company is payable the 1st prox.

THE North Penn Gas Company proposes to construct a gas plant in Fort Washington, Pa., for the use of the residents of Fort Washington, Ambler, Penllyn, Springhouse, Gwynedel, North Wales and Landsdale.

THE voters of Fairfield (Ia.) have sanctioned an extension of the franchise of the Fairfield Gas and Electric Company for a period of 15 years.

MR. F. L. FULLER, Managing Director of the Norwalk (O.) Gas and Electric Company, is our authority for the statement that its properties have not been sold to the Logan Gas and Fuel Company.

ON January 1 the Milwaukee Gas Company will establish 65 collection offices where patrons may pay their bills without cost to them. For some years the Company has had agencies at the branch express money order offices, where patrons could buy orders at 5 cents or more, but the new plan will give a collection office that will be open the first 10 days of the month at points so selected that patrons will not have to go more than 4 or 6 blocks from their homes, and where they may pay the bills without charge under the same conditions as at the general office.

MR. FREDERICK BURNETT, formerly Manager of the Nelson (B. C.) Gas and Coke Company, has accepted a responsible position in the service of the Economical Gas Apparatus Construction Company, of East Toronto, Ont.

THE New Orleans (La.) Lighting Company has completed the laying of the high pressure main under the Mississippi river, extending from New Orleans to the district known as Algiers, and is now satisfactorily supplying gas to the residents thereof. Mr. Thomas D. Miller, the Manager of the New Orleans Lighting Company, through his commonsense business methods, is in great favor with its customers.

MR. J. H. MAXON, formerly in control of the management of the Coshocton (O.) Gas Company, has assumed charge of the electric plant at Gallipolis, O., which property he recently acquired by purchase.

THE regular quarterly dividend of 1½ per cent. on the shares of the Peoples Gas Light and Coke Company, of Chicago, is payable the 25th inst.

AT the Dusseldorf Exhibition, which terminated some weeks ago, the highest award of merit (a gold medal) was awarded to the Hunt conveyor, which machine, as our readers know, is manufactured by the C. W. Hunt Company, West New Brighton, N. Y.

THE proprietors of the Springfield (Mass.) Gas Light Company have declined to sell any part of its property fronting on the river for the use of the Naval Militia as a site for a boat house. Manager Thompson was quite positive in his argument that in a very short time every foot owned

by the Company on the river will be required for extensions to the works.

A CORRESPONDENT in Pittsburg, Pa., writing under date of the 8th inst., forwards the following: "For the first time in 27 years a strike of the employees of the Consolidated Gas Company, of this city, occurred. Yesterday morning 100 men employed as gas makers and helpers walked out of the works on Second avenue, leaving the Company temporarily in a predicament. The strike is a peculiar one. The men and their helpers are members of a new union, which was formed during last spring by the American Federation of Labor. The officials of the Company had no objection to the union. One of the gas makers named Finn, and his helper had, however, steadily refused to join the union, and after many entreaties by the union men they gave the matter up. Last Wednesday Finn and his helper decided that they would go into the union, but when they announced this fact to the leaders they were told that it was too late, that they would now lose their jobs, as the men would insist upon their discharge, or else would strike. The union notified the officials of the Company of their intention, and yesterday Gen. Manager Robert Young went to the plant and held a conference with the men. He declined to discharge Finn and his helper, claiming that they had done nothing to warrant it. The men walked out at 10 o'clock in the morning. As soon as this was done the officials took determined action to protect their own interests, and told the men that unless they returned at once they would fill their places. The officials speedily engaged a number of men to keep the plant going, and there was no let up in the supply of gas."

"P." SENDS the following clipping from Toledo, O.: "H. A. Fox, a wholesale liquor merchant on Huron street near Adams, this city, has had an experience in the matter of artificial lighting that he does not care to duplicate. After one of the most stubborn contests ever waged in the Lucas county courts, Mr. Fox has been compelled to pay the claim of the Toledo Gas Light and Coke Company. It seems that about two years ago Mr. Fox entered into an agreement with the Toledo Railways and Light Company to light his place on Huron street. He believed he was paying too much for the service he was receiving, and he made a deal with the Toledo Gas Light and Coke Company, whereby he was to receive an equivalent of the light supplied by the Electric Company for one-third the price. The Gas Company put in fixtures and equipped the place as per agreement. At the expiration of 14 days, however, he found that his gas bill was much more than his electric lighting bill had been, and he thereupon made arrangements with the Toledo Incandescent Light Company to use natural gas. He ordered the fixtures supplied by the Toledo Gas Company taken out. The Company, however, not only refused to take out the fixtures, but put in a claim of $40 for them. The matter was taken into the courts, and has been fought to a finish with the result that Mr. Fox has to meet the judgment."

MR. FREDERICK TAG has resigned from the service of the Adrian (Mich.) Gas Company.

MR. LOUIS SANDS and the Manistee (Mich.) Gas and Fuel Company have transferred all their interests in the Sands Electric Lighting Company and in the Gas and Fuel Company to a succeeding corporation, to be known as the Manistee Gas and Electric Company, which was recently incorporated by Messrs. E. C. Dummeyer, Samuel V. Perrott, Henry C. Ulen, Jr., Albert G. Perrott and Matthew J. Scully, of Indianapolis, Ind. The firm was incorporated for $200,000. It is thought by those in a position to know that the new Company will give its attention largely to the extension of the gas lighting plant, which, under its former management, was operated as a side issue, electric lighting having been given the greatest prominence. The new owners took over the active management of the plant early this month.

THE Logansport and Wabash Valley Natural Gas Company has declined to take on any more consumers in Decatur, Ind. Lack of supply is the cause of the order.

MESSRS. P. PLANTINGA and W. E. Steinwedell, who recently resigned from the service of the Western Gas Construction Company, of Fort Wayne, Ind., have decided to engage in the gas works construction business on their own account. Mr. A. M. Smith, a brother-in-law of Mr. Steinwedell, will be associated with them. The headquarters of the new firm will be in Cleveland, O.

THE following comes to us from Milwaukee, Wis., under date of the 7th inst.: "With the completion of the new plant of the Milwaukee Gas Light Company in the Menomonee Valley, which will be early in 1903, the Company will materially reduce the price of gas for all purposes to its customers in Milwaukee. It will also be enabled, by reason of the magnitude and perfection of the new plant, to greatly extend its facilities for furnishing gas and to thereby increase its annual output. This has been fully confirmed by General Manager E. G. Cowdery. While admitting that such was the intention of the Company, he stated that he could not at this time give full particulars as to the percentages of decrease in prices for gas, as the Directors have not as yet fully agreed upon just the amount of reduction, and just how it shall be made, but the Board had agreed that a reduction will be made. Mr. Cowdery also stated that the Company believes that the liberal reductions to be made in prices for gas will materially increase the output of the Company, and that, taking into consideration that prices of all other products, including fuel, are steadily advancing, it is thought the reduction in gas will have a double significance. The Company believes that the completion of the new works will give it the ability to extend the uses of gas into all homes of the city both for fuel and lighting purposes, and it is the intention, Mr. Cowdery states, to make prices such as to encourage this."

THE proprietors of the Sterling (Ills.) Gas and Electric Light Company have determined on bonding those properties in the sum of $250,000. The bonds are to bear 5 per cent. interest, are redeemable in 1927, and $100,000 thereof will be issued at once.

SOME time ago we reported the sale of the Bellingham Bay gas properties, of Fairhaven, Wash., to a syndicate who reorganized the concern under the name of the Whatcom-Fairhaven Gas Company. Now it is said that the properties have been sold to Messrs. Stone & Webster, of Boston, Mass., who propose to make extensive improvements on the works.

MESSRS. HOYT AND MILLER, of the San Luis Obispo (Cal.) Gas Company, have secured control of the local electric lighting concern.

THE Ordinance Committee of the Atlantic City (N. J.) Council has virtually decided to report adversely on the proposition to issue a franchise to the promoters of the opposition concern known as the Peoples Gas Company.

THE voters of Holland, Mich., have decided not to engage the authorities of that place in the operating of a municipal gas plant.

HERR WM. CREMER, Superintendent of the works at Enskirchen, Germany, referring to observations noticed by others, that ammoniacal liquor detrimentally affects cement mortar and coating of tanks, recommends that the surfaces of such be painted with liquid glass (tungstate of soda), because that would not only protect the cement, but render the surfaces treated quite leakage proof. Herr Cremer states he has found the above to be an excellent remedy.

THE United Electric Light Company, of Springfield, Mass., having petitioned the State Board of Gas and Electric Light Commissioners for the right to increase its capital stock in a sum necessary to produce $145,000, a hearing thereon was held the 7th inst. Decision was reserved. The hearing developed the fact that the Company's business was rapidly increasing.

New Coal Fields in Belgium.

United States Consul, A. A. Winslow, Liege, informs the State Department that in 1901 he noted the discovery of a new soft coal basin in the province of Luxembourg, north of that city. Since then extensive soundings have been made over a considerable territory. The deposit underlies many square miles of the northern part of Belgium and the southern part of Holland.

One of the veins at a depth of from 1,000 to 1,500 feet below the surface, is from 15 to 17 feet thick, and of a very fine quality of coal. It is estimated that this new field contains more than 500,000,000 tons of a good grade of coal, and extensive preparations are being made to open up the mines. The Government proposes to enlarge the canals in that part of Belgium, dig new ones and open new lines of railroads. The working of these mines will be more difficult and expensive than of the other mines of Belgium, because of their depth and the presence of more water; but it is thought this will be more than counterbalanced by the thickness of the veins.

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Notification Respecting Advertising.—Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

AGENTS:
New York—American News Co. 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, NOVEMBER 17, 1902.

The Market for Gas Securities.

The demoralized state of the general stock market is responsible for the quotations on gas shares reported to-day, Friday. If one were to look for changes in real values, as reflected in the volume of business being transacted by the manufacturing concerns involved, Consolidated gas, instead of showing a loss of 5 points for the week should be showing a gain of 10. However, the plain case is that the closing was made in the Exchange this afternoon at 211¼ to 212. It is noteworthy that the present slump does not show very strong in bond quotations.

Brooklyn Union is offered at the abnormally low price of 222 ex dividend of 2 per cent., and to our mind no other stock on the market offers better opportunity for profit than Brooklyn Union does at the registered figures. Baltimore Consolidated is weaker, and Peoples, of Chicago, is 99¼ bid, ex dividend of 1¼ per cent. The Laclede Gas Light Company, of St. Louis, Mo., has declared its semi-annual dividend of 2 per cent. on the preferred, payable the 15th prox.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.
16 WALL STREET, NEW YORK CITY.

NOVEMBER 17.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	211¾	212
Central Union, Bonds, 5's	3,000,000	1,000	110	112
Equitable Bonds, 6's	1,000,000	1,000	105	
" 1st Con. 5's	2,300,000	1,000	118	120
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	350	..
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co..				
Bonds, 5's	11,000,000	1,000	112⅛	113
Northern Union, Bonds, 5's.	1,250,000	1,000	108	110
New York and East River..				
Bonds 1st 5's	3,500,000	1,000	112	113
" 1st Con. 5's	1,500,000	..	109	111
Standard	5,000,000	100	130	140
Preferred	5,000,000	100	150	160
Bonds, 1st Mortgage, 5's	1,500,000	1,000	115½	118
Yonkers	299,850	500	130	.
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	219	222 x
" " Bonds (5's)	15 000,000	1,000	119	119⅛
Bay State	50,000,000	50	1¼	1⅜
" Income Bonds	2,000,000	1,000	.	75
Binghamton Gas Works	450,000	100	28	30
" 1st Mtg. 5's	509,000	1,000	93	96
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	10½	11
" " Bonds, 5's	5,256,000	1,000	79	81
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000		
Central San Francisco	000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas & Elec. Co.	29,500,000	100	99	100
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	101	101½
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	88¾	89¼
Preferred	3,026,500	100	107½	109
Consumers, Jersey City Bonds	600,000	1,000	102	103
Consumers, Toronto	1,700,000	50	218	225
Consolidated, Baltimore	11,000,000	100	72¾	73
Mortgage, 6's	3,500,000	..	..	115
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	.	112
Consolidated Gas Co. of N.J.	1,000,000	100	15	17
" Con. Mtg. 5's	880,000	1,000	85	87
Consolidated G. & E. Co.'s.				
Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,825,500	50	.	89
" Prior Lien 5's	5,603,000	1,000	99½	100
Detroit Gas Co., 5's	382,000	1,000	77	79
" Inc. 5's	15,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	34	38
Fort Wayne	2,000,000	..	.	.
" Bonds	2,000,000	..	55	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	245	265
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	70	80
" Bonds, 6's	2,550,000	..	102¾	104½
Jackson Gas Co.	250,000	50	73	75
" 1st Mtg. 5's	290,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	84	85
Preferred	2,500,000	100	100	110
Bonds	10,000,000	1,000	109½	110
Lafayette Gas Co., Ind.	1,000,000	100	.	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	112	120
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	107½	108¼
" 6 per cent. scrip, due 1910	100,000	25	25	87
Montreal, Canada	2,000,000	100	218	184¾
Newark, N. J., Con. Gas Co	6,000,000	..	56	58
Bonds, 6's	4,600,000	..	105	105¾
New Haven	1,000,000	25	300	325
Nashville Gas Lt. Co.	1,000,000	100	110	
Oakland, Cal.	2,000,000	..	46	47
" Bonds	751,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	99¼	99½ x
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
2d "	2,500,000	1,000	104	
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	48	48½
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgage 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	113½	115
General Mortgage, 5's	2,465,000	1,000	92	94
St. Joseph Gas Co.				
" 1st Mtg. 5's	751,000	1,000	95	96⅛
Syracuse, N. Y.	1,975,000	100	29	..
Bonds	2,047 000	1,000	99½	100
Washington, D. C	2,600,000	20	375	380
First mortgage 6's	600,000	..	..	..
Western, Milwaukee.				
Bonds, 5's	4,000,000	..	109⅛	110
Wilmington, Del.	600,000	50	232	..

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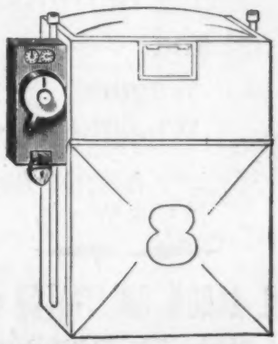

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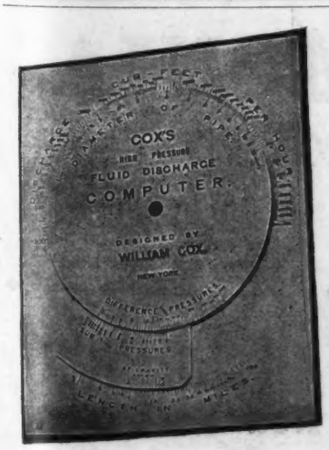

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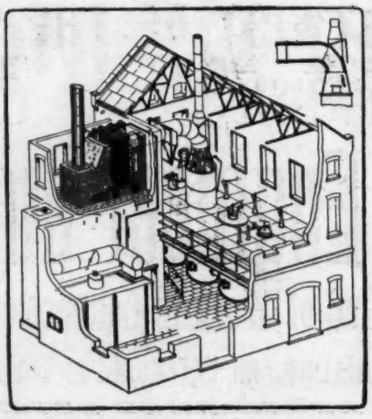

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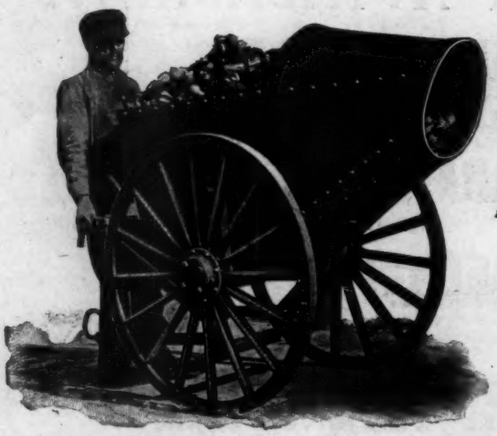

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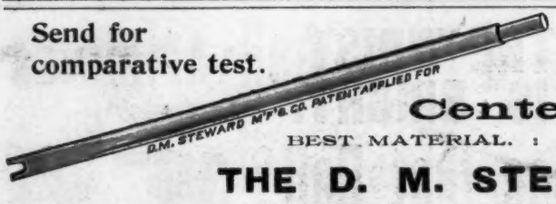

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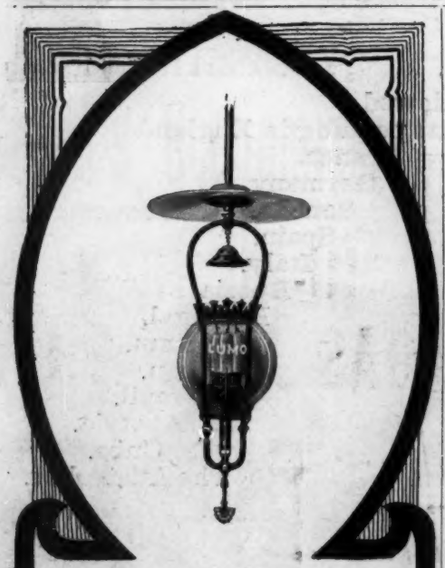

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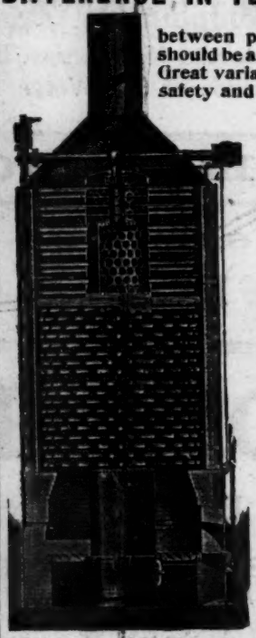

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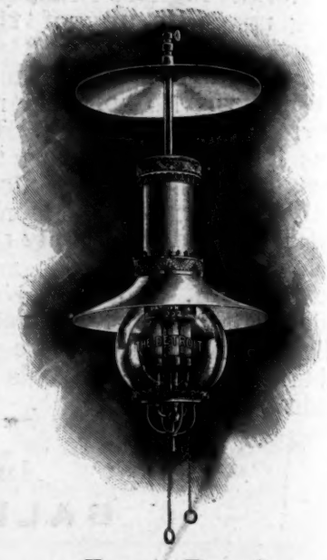

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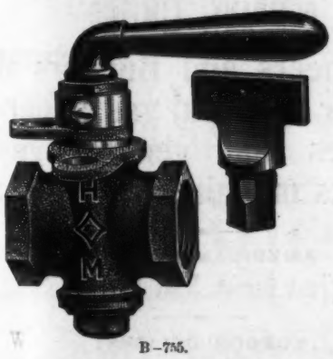

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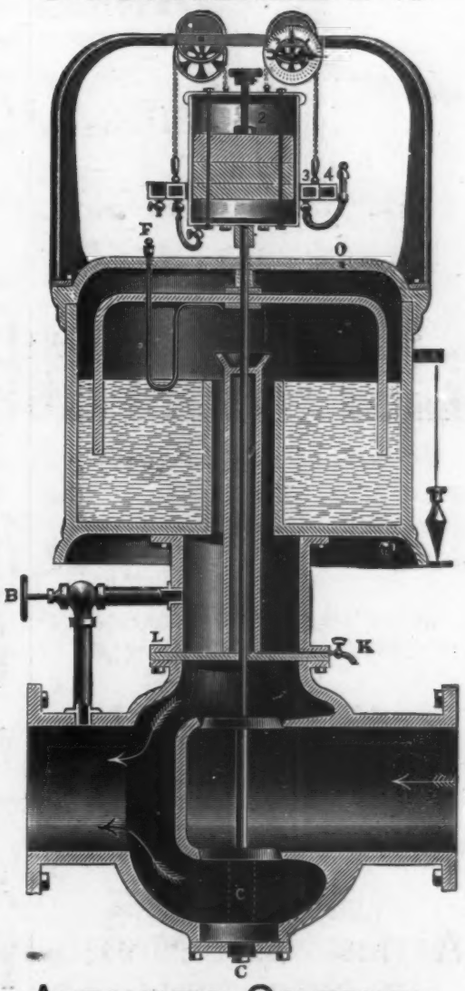

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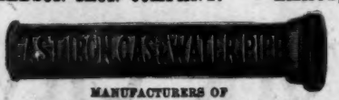

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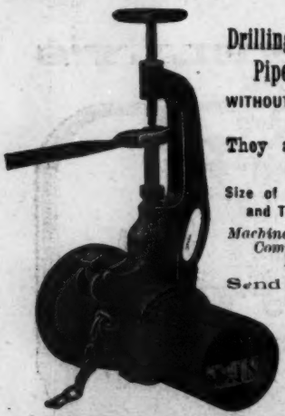

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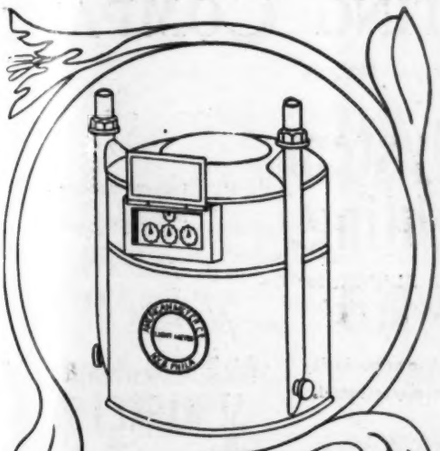

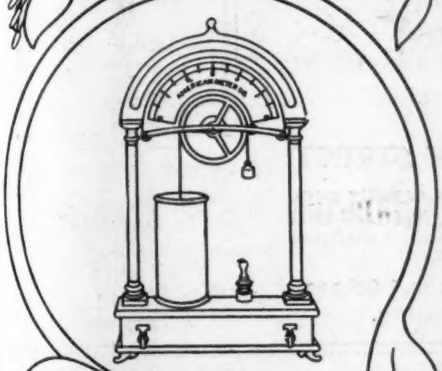

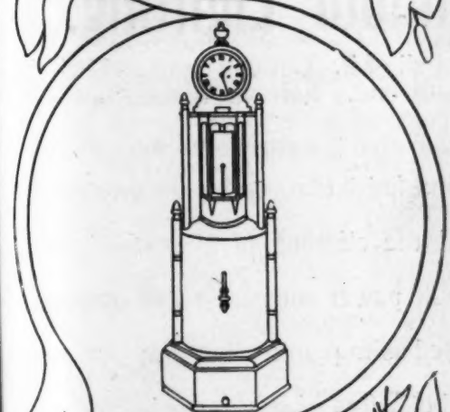

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SAN FRANCISCO.

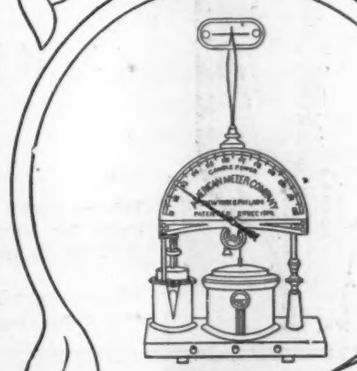
PUBLIC LIGHTING TABLE.

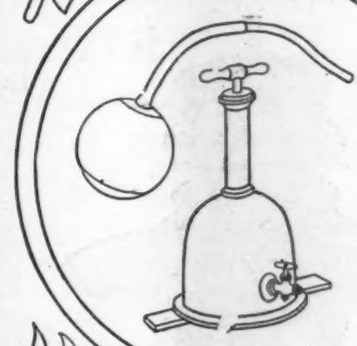
DECEMBER, 1902.

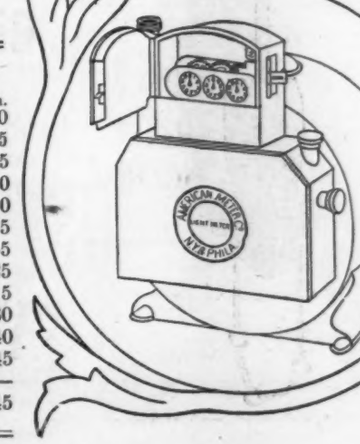
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Mon.	1	5.00 PM	6.00 AM	4.20	6.10
Tue.	2	5.00	6.00	4.20	6.10
Wed.	3	5.00	6.00	4.20	6.15
Thu.	4	7.50	6.00	4.20	6.15
Fri.	5	8.40	6.00	4.20	6.15
Sat.	6	9.40	6.00	4.20	6.15
Sun.	7	10.40 FQ	6.10	4.20	6.15
Mon.	8	11.40	6.10	4.20	6.15
Tue.	9	12.50 AM	6.10	4.20	6.15
Wed.	10	1.50	6.10	4.20	6.20
Thu.	11	3.00	6.10	4.20	6.20
Fri.	12	4.10	6.10	4.20	6.20
Sat.	13	No L.	No L.	4.20	6.20
Sun.	14	No L. FM	No L.	4.20	6.20
Mon.	15	No L.	No L.	4.20	6.20
Tue.	16	5.10 PM	7.40 PM	4.20	6.20
Wed.	17	5.10	9.00	4.20	6.20
Thu.	18	5.10	10.10	4.20	6.20
Fri.	19	5.10	11.10	4.20	6.20
Sat.	20	5.10	12.20 AM	4.20	6.20
Sun.	21	5.10 LQ	1.20	4.20	6.20
Mon.	22	5.10	2.20	4.20	6.20
Tue.	23	5.10	3.20	4.20	6.20
Wed.	24	5.10	4.20	4.20	6.25
Thu.	25	5.10	5.20	4.20	6.25
Fri.	26	5.10	6.20	4.20	6.25
Sat.	27	5.10	6.20	4.20	6.25
Sun.	28	5.10	6.20	4.20	6.25
Mon.	29	5.10 NM	6.20	4.20	6.25
Tue.	30	5.10	6.20	4.20	6.25
Wed.	31	5.10	6.20	4.20	6.25

TOTAL HOURS LIGHTING DURING 1902.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	238.30	January	423.20
February	196.20	February	355.25
March	196.20	March	355.35
April	166.40	April	298.50
May	151.40	May	264.50
June	131.10	June	234.25
July	142.40	July	243.45
August	162.00	August	280.25
September	179.00	September	321.15
October	216.30	October	374.30
November	224.10	November	401.40
December	250.00	December	433.45
Total, yr.	2255.00	Total, yr.	3987.45







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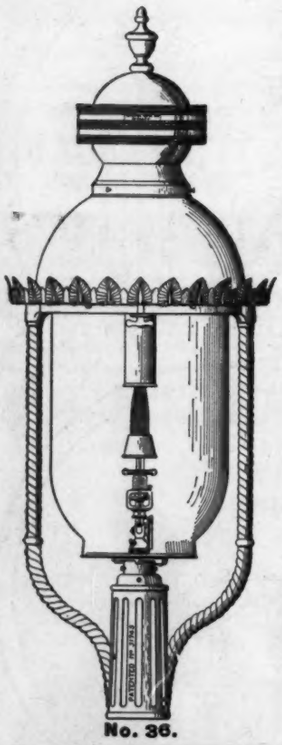

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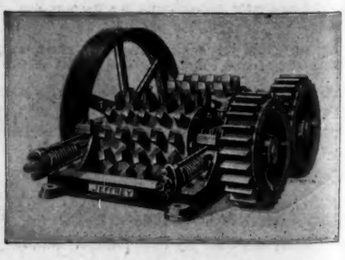

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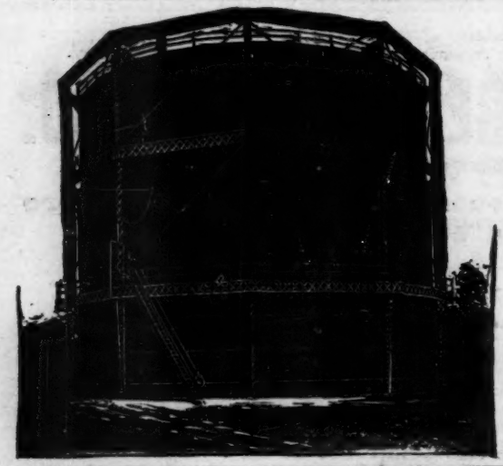

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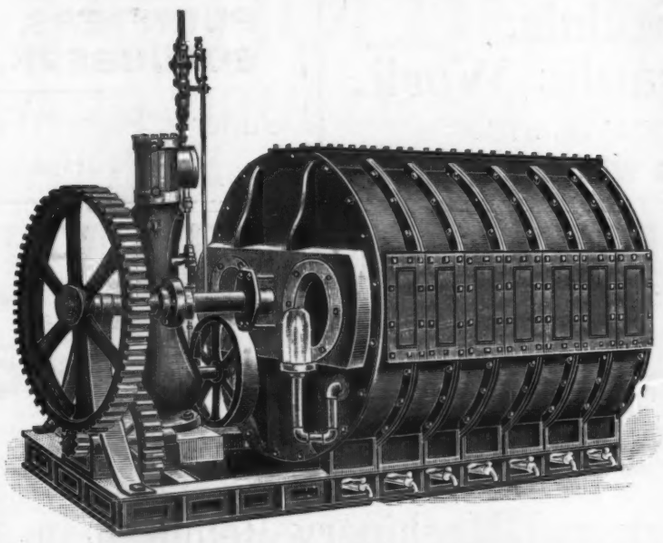

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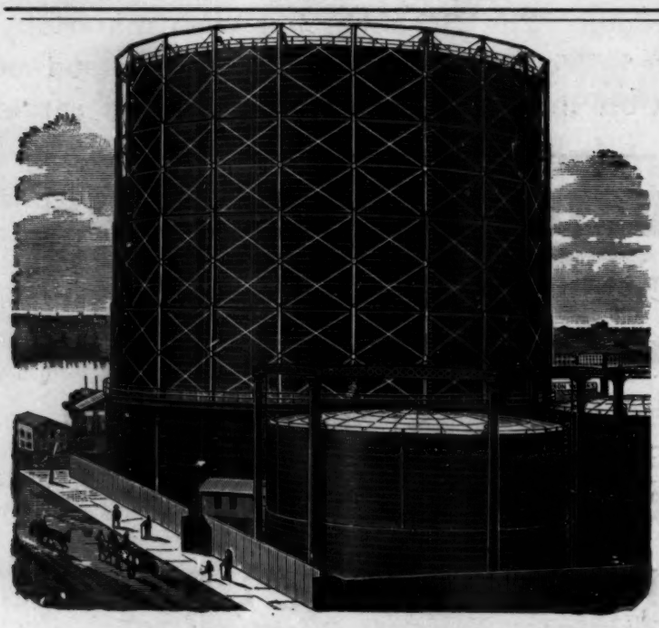

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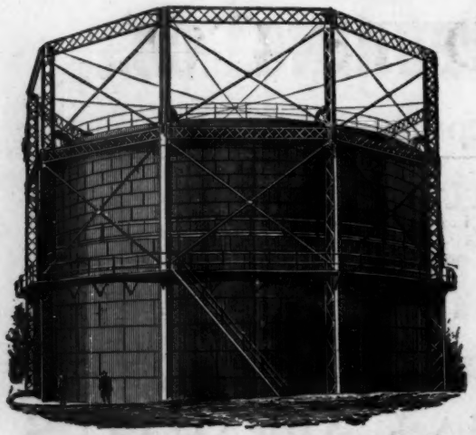

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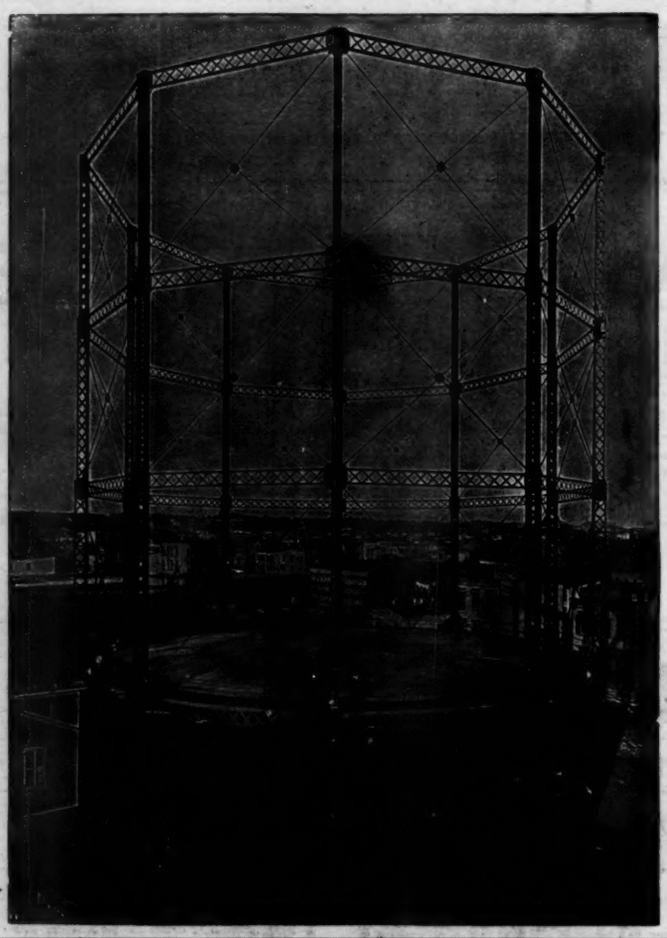

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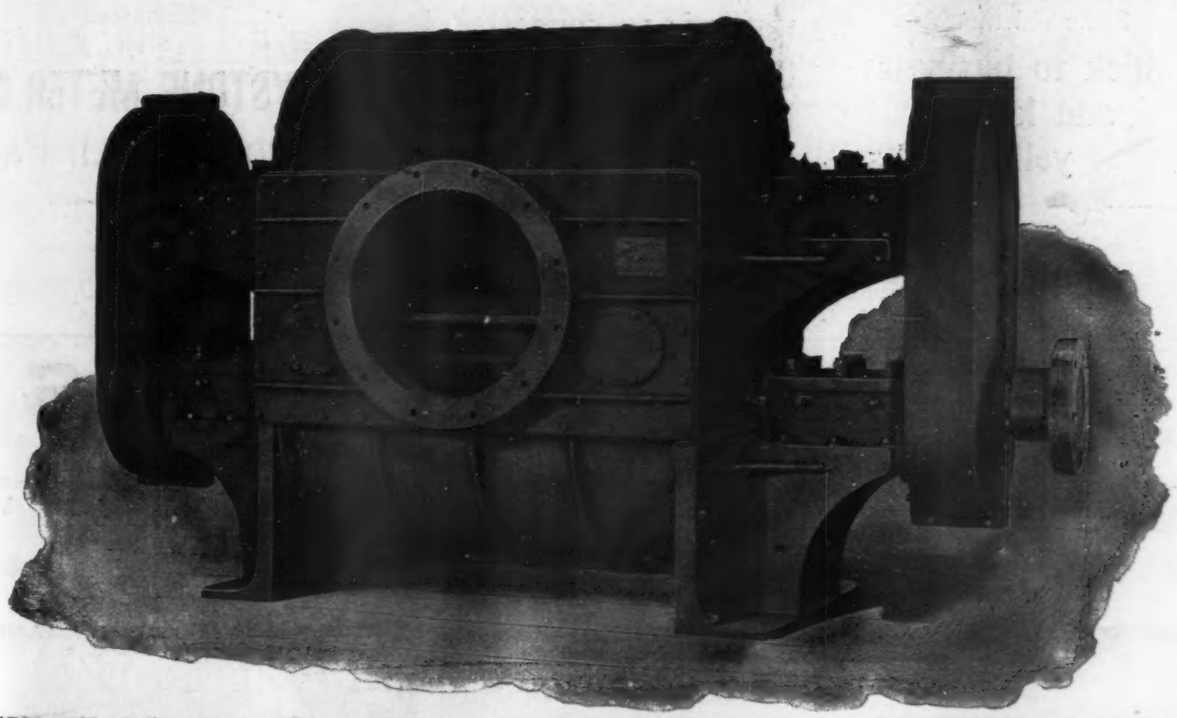

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